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U.S. ENVIRONMENTAL PROTECTION AGENCY

Office of Radiation Programs

## INTERNATIONAL NUMERICAL MULTIPLE AND SUBMULTIPLE PREFIXES

| Multiples and submultiples | Prefixes | Symbols | Pronunciations |
|---|---|---|---|
| $10^{12}$ | tera | T | tĕr'a |
| $10^{9}$ | giga | G | jĭ'ga |
| $10^{6}$ | mega | M | mĕg'a |
| $10^{3}$ | kilo | k | kĭ'lo |
| $10^{2}$ | hecto | h | hĕk'to |
| 10 | deka | da | dĕk'a |
| $10^{-1}$ | deci | d | dĕs'i |
| $10^{-2}$ | centi | c | sĕn'ti |
| $10^{-3}$ | milli | m | mĭl'i |
| $10^{-6}$ | micro | $\mu$ | mi'kro |
| $10^{-9}$ | nano | n | năn'o |
| $10^{-12}$ | pico | p | pē'ko |
| $10^{-15}$ | femto | f | fĕm'to |
| $10^{-18}$ | atto | a | ăt'to |

## SYMBOLS, UNITS, AND EQUIVALENTS

| Symbol | Unit | Equivalent |
|---|---|---|
| Å | angstrom | $10^{-10}$ meter |
| A | ampere(s) | |
| a | annum, year | |
| BeV | billion electron volts | GeV |
| Ci | curie | $3.7 \times 10^{10}$ dps-$2.22 \times 10^{12}$ dpm |
| cpm | counts per minute | |
| dpm | disintegrations per minute | |
| dps | disintegrations per second | |
| eV | electron volt | $1.6 \times 10^{-12}$ ergs |
| g | gram(s) | $3.527 \times 10^{-2}$ ounces= $2.205 \times 10^{-3}$ pounds |
| Hz | hertz | cycle per second |
| kVp | kilovolt peak | |
| m | meter(s) | 39.4 inches |
| $m^3$ | cubic meter(s) | |
| $mCi/mi^2$ | millicuries per square mile | 0.386 $nCi/m^2$ ($mCi/km^2$) |
| mi | mile(s) | |
| ml | milliliter(s) | |
| $nCi/m^2$ | nanocuries per square meter | 2.59 $mCi/mi^2$ |
| R | roentgen | |
| rad | unit of absorbed radiation dose | 100 ergs/g |
| s | second | |

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# RADIATION DATA AND REPORTS

Volume 14, Number 12, December 1973

*Radiation Data and Reports*, a monthly publication of the Environmental Protection Agency presents data and reports provided by Federal, State, and foreign governmental agencies, and other cooperating organizations. Pertinent original data and interpretive manuscripts are invited from investigators.

In August 1959, the President directed the Secretary of Health, Education, and Welfare to intensify Departmental activities in the field of radiological health. The Department was assigned responsibility within the Executive Branch for the collation, analysis, and interpretation of data on environmental radiation levels. This responsibility was delegated to the Bureau of Radiological Health, Public Health Service. Pursuant to the Reorganization Plan No. 3 of 1970, effective December 2, 1970, this responsibility was transferred to the Radiation Office of the Environmental Protection Agency which was established by this reorganization.

The Federal agencies listed below appoint their representatives to a Board of Editorial Advisors. Members of the Board advise on general publications policy; secure appropriate data and manuscripts from their agencies; and review those contents which relate to the special functions of their agencies.

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Department of Commerce
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Environmental Protection Agency
Atomic Energy Commission

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U.S. ENVIRONMENTAL PROTECTION AGENCY

Russell E. Train, Administrator

# Reports

## Vertical Distribution of Fallout Cesium-137 in Cultivated Soils[1]

*Jerry C. Ritchie and J. Roger McHenry*[2]

**Fallout cesium-137 was found to be evenly distributed in the upper 15-20 cm of cultivated soils of five watersheds in the mid-United States. This distribution pattern is markedly different from the vertical distribution of cesium-137 in noncultivated soils.**

Fallout cesium-137 has been shown to be concentrated in the upper few centimeters in untilled soil (*1–3*) and usually shows an exponential decrease with depth in the soil profile (*4–5*). Few studies (*6–7*) have dealt with the distribution of cesium-137 in cultivated soils. This study concentrated on the distribution of fallout cesium-137 in cultivated soils from five watersheds in the mid-United States.

### *Methods and materials*

Two or more soil samples were collected in 5-cm increments to a depth of 25 to 30 cm in each watershed. Surface area of each sample was 500 cm$^2$. The samples were dried and sieved through a 12-mm screen. From 2,000 to 3,000 grams of the sample was put into Marinelli-type beakers, sealed and stored for a minimum of 4 weeks before counting. Gamma-ray spectrometric analyses were made using a 1,024-channel pulse height analyzer (*8*). The spectra were reduced to concentration values for cesium-137 using a least squares technique (*9*). The detection limit of the system for cesium-137 is approximately 0.1 pCi/g. Particle size analysis and cation exchange capacity were determined on all samples. No significant differences were found for particle size distribution or cation exchange capacity for samples taken from the same watershed.

### *Results and discussion*

The vertical distribution of fallout cesium-137 is given for soils from five watersheds in four States (table 1). Cesium-137 is uniformly distributed in the upper 15 or 20 cm of the soil profiles, and decreases sharply below this depth. The Durant 1A watershed soil has a peak concentration of cesium-137 from the 5 to 15 cm depth. The distribution of cesium-137 in the upper 15 to 20 cm of cultivated soil would be due to the yearly mixing of these soils during tillage, since cesium-137 is tightly adsorbed to the finer soil particles and movement by natural chemical process is limited (*10*). The normal plow depth in these watersheds is 15 to 20 cm. Cline and Richard (*6*) and Walton (*3*) found a peak concentration of cesium-137 between the 10 to 20 cm depth, or at about the bottom of the plow layer. The uniform mixing in most of our samples would be caused by a continuing mixing of the soils by tillage operations over the period since fallout began.

The distribution of cesium-137 is markedly different in tilled soils as compared with nontilled soils (table 1). Differences in total concentration between tilled and nontilled soil in the watershed is due to erosional differences

[1] Contribution of the USDA Sedimentation Laboratory, North Mississippi-Alabama Area, Agricultural Research Service, U.S. Department of Agriculture in cooperation with the University of Mississippi, the Mississippi Agricultural and Forestry Experiment Station, and the U.S. Atomic Energy Commission (Contract No. AT(49–7)–3029).

[2] Botanist and research chemist, Oxford, Miss. 38655.

**Table 1. Vertical distribution of fallout cesium-137 in tilled and nontilled soils**

| Depth (cm) | Cesium-137 concentration (nCi/m²) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Watershed | | | | | | | | | |
| | Smith [a] | | Murphy [a] | | Ashland [b] | | Durant 1A [c] | | Elm Creek [d] | |
| | Tilled | Non-tilled | Tilled | Non-tilled | Tilled | Non-tilled | Tilled | Non-tilled | Tilled | Non-tilled |
| 0– 5 | 29.3 | 135.2 | 31.4 | 133.9 | 27.3 | 100.7 | 11.4 | 51.0 | 47.5 | 85.1 |
| 5–10 | 32.9 | 22.2 | 33.2 | 16.9 | 25.5 | 15.2 | 19.6 | 27.3 | 46.7 | 25.2 |
| 10–15 | 23.4 | | 31.5 | | 26.9 | | 16.2 | | 22.7 | |
| 15–20 | 10.1 | | 20.3 | | 27.3 | | 12.6 | | 6.7 | |
| 20–25 | 5.0 | | 3.4 | | 17.2 | | 4.3 | | | |
| 25–30 | | | | | 4.0 | | | | | |

[a] Holly Springs, Miss.
[b] Ashland, Mo.
[c] Durant, Okla.
[d] Gainesville, Tex.

between sites. In the nontilled soils, the highest concentration is in the upper 5 cm, decreasing below this depth. In nontilled soils, the original depositional cesium-137 approaches a planar source at the surface of the soil and the distribution below this planar source decreases sharply. In cultivated soil, the original deposition of cesium-137 as a planar source is dispersed throughout the top 10 or 20 cm, or more, depending on the tillage practices used. Below this mechanically mixed layer, the cesium-137 distribution decreases sharply with depth as in nontilled soils.

These two distinct distribution patterns of cesium-137 in tilled and nontilled soils are important in understanding the movement of fallout cesium-137 in watershed ecosystems. Movement and redistribution of cesium-137 in a watershed will be influenced by this depth mixing of fallout. Models for the movement of cesium-137 in watershed ecosystems and for the movement of cesium-137 from the soil into plants should account for these two patterns.

## REFERENCES


(*1*) MISHRA, U. C. and S. SADASIVAN. Fallout radioactivity in Indian soils. Health Phys 23:55–62 (1972).

(*2*) GERSPAR, P. L. Effect of American beech trees on the gamma radioactivity of soils. Soil Science Society of America Proceedings 34:318–323 (1970).

(*3*) WALTON, A. The distribution in soils of radioactivity from weapons test. J Geophysical Res 68: 1485–1496 (1963).

(*4*) BECK, H. L. Environmental gamma radiation from deposited fission products, 1960–1964. Health Phys 12:313–322 (1966).

(*5*) BENNETT, B. G. Estimation of gonadal adsorbed dose due to environmental gamma radiation. Health Phys 19:757–767 (1970).

(*6*) CLINE, J. F. and W. H. RICHARD. Radioactive strontium and cesium in cultivated and abandoned field plots. Health Phys 23:317–324 (1972).

(*7*) HAWTHORNE, H. A. Fission-product cycles in an agricultural system. 1. Sample heterogeneity. U.S. Atomic Energy Commission Conference 765: 711–722 (1965).

(*8*) RITCHIE, J. C. and J. R. McHENRY. Determination of fallout $^{137}Cs$ and natural gamma-ray emitting radionuclides in sediment. Intl J Applied Radiat Isotop 24: 575–578 (1973).

(*9*) SCHONFELD, E. Alpha M—an improved computer program for determining radioisotopes by least squares resolution of gamma-ray spectra. Oak Ridge National Laboratory Report ORNL 3975 (1966).

(*10*) TAMURA, T. Selective sorption reactions of cesium with mineral soil. Nuclear Safety 5:262–268 (1964).

# Technical Notes

## Iodine-131 in Milk Samples, July 9, 1973 through August 23, 1973

*Eric Geiger*[1] *and Milton A. Trautman*[2]

Eberline Instrument Corporation, using a method similar to that specified in AEC Regulatory Guide 4.3, has, since June 1973, made high-sensitivity measurements of iodine-131 in milk samples on a routine basis. Using this method, measurements were made of unusual concentrations of iodine-131 in milk which we believe are attributable to debris from the atmospheric nuclear detonation in the People's Republic of China at about midnight, e.d.t. on June 26, 1973. The iodine-131 was widely dispersed throughout the midwestern part of the United States (table 1), and was first detected in milk collected on July 9, 1973. Maximum levels were reached during the following 2 weeks with measurable concentrations observed until the middle of August.

The presence of iodine-131 was confirmed by high resolution gamma spectrometry (using groups of samples) and by half-life studies. We did not detect iodine-131 in air samples (charcoal cartridges) or vegetation samples collected during the same period.

Table 1. Average concentration of iodine-131 in milk

| Date collected (1973) | Concentration[a] (pCi/liter) | | |
|---|---|---|---|
| | Eastern Nebraska | Eastern Iowa | Eastern Illinois |
| Prior to July 9 | | <0.5 | <0.5 |
| July 9 | | <.4 (3) | .6 (2) |
| July 10 | | .4 (2) | |
| July 11 | | .6 (6) | |
| July 12 | 0.9 (3) | | |
| July 16 | | | 2.1 (2) |
| July 19 | 1.4 (3) | | |
| July 23 | | | .9 (2) |
| July 24 | | 1.7 (8) | |
| July 26 | 1.9 (3) | | |
| July 30 | | | .7 (2) |
| July 31 | .6 (3) | | |
| Aug 6 | | | .2 (2) |
| Aug 9 | .2 (3) | | |
| Aug 13 | | .8 (5) | |
| Aug 15 | | | .3 (2) |
| Aug 16 | .3 (3) | | .3 (2) |
| Aug 20 | | .3 (5) | |
| Aug 23 | .1 (3) | | |

[a] Blank spaces indicate that no samples were collected at that location on that date. Numbers in parentheses indicate number of dairies included in the average. Counting errors ($2\sigma$) ranged from 0.05 to 0.5 pCi/liter depending on counting time and chemical yield.

[1] Eberline Instrument Corporation, Santa Fe, N. Mex.
[2] Eberline Instrument Corporation, West Chicago, Ill.

# SECTION I. MILK AND FOOD

## Milk Surveillance, August 1973

Although milk is only one of the sources of dietary intake of environmental radioactivity, it is the food item that is most useful as an indicator of the general population's intake of radionuclide contaminants resulting from environmental releases. Fresh milk is consumed by a large segment of the population and contains several of the biologically important radionuclides that may be released to the environment from nuclear activities. In addition, milk is produced and consumed on a regular basis, is convenient to handle and analyze, and samples representative of general population consumption readily can be obtained. Therefore, milk sampling networks have been found to be an effective mechanism for obtaining information on current radionuclide concentrations and long-term trends. From such information, public health agencies can determine the need for further investigation or corrective public health action.

The Pasteurized Milk Network (PMN) sponsored by the Office of Radiation Programs, Environmental Protection Agency, and the Office of Food Sanitation, Food and Drug Administration, Public Health Service, consists of 65 sampling stations: 63 located in the United States, one in Puerto Rico, and one in the Canal Zone. Many of the State health departments also conduct local milk surveillance programs which provide more comprehensive coverage within the individual State. Data from 16 of these State networks are reported routinely in *Radiation Data and Reports*. Additional networks for the routine surveillance of radioactivity in milk in the Western Hemisphere and their sponsoring organizations are:

Pan American Milk Sampling Program (Pan American Health Organization and U.S. Environmental Protection Agency)—7 sampling stations

Canadian Milk Network (Radiation Protection Division, Canadian Department of National Health and Welfare)—16 sampling stations.

The sampling locations that make up the networks reporting presently in *Radiation Data and Reports* are shown in figure 1. Based on the similar purpose for these sampling activities, the present format integrates the complementary data that are routinely obtained by these several milk networks.

### *Radionuclide and element coverage*

Considerable experience has established that relatively few of the many radionuclides that are formed as a result of nuclear fission become incorporated in milk (*1*). Most of the possible radiocontaminants are eliminated by the selective metabolism of the cow, which restricts gastrointestinal uptake and secretion into the milk. The five fission-product radionuclides which commonly occur in milk are strontium-89, strontium-90, iodine-131, cesium-137, and barium-140. A sixth radionuclide, potassium-40, occurs naturally in 0.0118 percent (*2*) abundance of the element potassium, resulting in a specific activity for potassium-40 of 830 pCi/g total potassium.

Two stable elements which are found in milk, calcium and potassium, have been used as a means for assessing the biological behavior of metabolically similar radionuclides (radio-


**Figure 1. Milk sampling networks in the Western Hemisphere**

strontium and radiocesium, respectively). The contents of both calcium and potassium in milk have been measured extensively and are relatively constant. Appropriate values and their variations, expressed in terms of 2 standard deviations ($2\sigma$), for these elements are 1.16 ± 0.08 g/liter for calcium and 1.51 ± 0.21 g/liter for potassium. These figures are averages of data from the PMN for May 1963–March 1966 (*3*) and are used for general radiation calculations.

*Accuracy of data from various milk networks*

In order to combine data from the international, national, and State networks considered in this report, it was first necessary to determine the accuracy with which each laboratory is making its determinations and the agreement of the measurements among the laboratories. The Analytical Quality Control Service of the Office of Radiation Programs conducts periodic studies to assess the accuracy of determinations of radionuclides in milk performed by interested radiochemical laboratories. The generalized procedure for making such a study has been previously outlined (*4*).

The most recent study was conducted during June 1972 with 37 laboratories participating in an experiment on a milk sample containing known concentrations of iodine-131, cesium-137, strontium-89, and strontium-90 (*5*). Of the 18 laboratories producing data for the network reports in *Radiation Data and Reports*, 14 participated in the study.

The accuracy results of this study for these 14 laboratories are shown in table 1. The accuracy of the cesium-137 measurements continues to be excellent as in previous experiments. However, both the accuracy and precision need to be improved for iodine-131, strontium-89, and strontium-90 which could probably be accomplished through recalibration.

*Development of a common reporting basis*

Since the various networks collect and analyze samples differently, a complete understanding of several parameters is useful for interpreting the data. Therefore, the various milk surveillance networks that report regularly were surveyed for information on analytical methods, sampling and analysis frequencies, and estimated analytical errors associated with the data.

In general, radiostrontium is collected by an ion-exchange technique and determined by beta-particle counting in low-background detectors, and the gamma-ray emitters (potassium-40, iodine-131, cesium-137, and barium-140) are determined by gamma-ray spectroscopy of whole milk. Each laboratory has its own modifications and refinements of these basic methodologies.

Many networks collect and analyze samples on a monthly basis. Some collect samples more frequently but composite the several samples for one analysis, while others carry out their analyses more often than once a month. Many networks are analyzing composite samples on a quarterly basis for certain nuclides. The frequency of collection and analysis varies not only among the networks but also at different stations within some of the networks. In addition, the frequency of collection and analysis is

**Table 1. Distribution of mean results, quality control experiment**

| Isotope and known concentration | | Number of laboratories in each category | | | | Experimental 2σ error (pCi/liter) |
|---|---|---|---|---|---|---|
| | | Acceptable [a] | Warning level [b] | Unacceptable [c] | Total | |
| Iodine-131 | (96 or 99 pCi/liter) | 7 (58%) | 1 ( 8%) | 4 (33%) | 12 | 6 |
| | (438 or 484 pCi/liter) | 11 (85%) | 0 | 2 (15%) | 13 | 25 or 28 |
| Cesium-137 | (53 or 54 pCi/liter) | 11 (92%) | 0 | 1 ( 8%) | 12 | 6 |
| | (295 or 303 pCi/liter) | 11 (85%) | 2 (15%) | 0 | 13 | 17 |
| Strontium-89 | (29 or 30 pCi/liter) | 9 (82%) | 0 | 2 (18%) | 11 | 6 |
| | (197 or 201 pCi/liter) | 3 (33%) | 1 (11%) | 5 (56%) | 9 | 11 or 12 |
| Strontium-90 | (32.1 or 32.4 pCi/liter) | 4 (33%) | 4 (33%) | 4 (33%) | 12 | 1.9 |
| | (150.5 or 151.2 pCi/liter) | 6 (55%) | 0 | 5 (45%) | 11 | 8.7 |

[a] Measured concentration equal to or within $2\sigma$ of the known concentration.
[b] Measured concentration outside $2\sigma$ and equal to or within $3\sigma$ of the known concentration.
[c] Measured concentration outside $3\sigma$ of the known concentration.

a function of current environmental levels. The number of samples analyzed at a particular sampling station under current conditions is reflected in the data presentation. Current levels for strontium-90 and cesium-137 are relatively stable over short periods of time, and sampling frequency is not critical. For the short-lived radionuclides, particularly iodine-131, the frequency of analysis is critical and generally is increased at the first measurement or recognition of a new influx of this radionuclide.

The data in table 2 show whether raw or pasteurized milk was collected. An analysis (*6*) of raw and pasteurized milk samples collected during January 1964 to June 1966 indicated that for relatively similar milkshed or sampling areas, the differences in concentration of radionuclides in raw and pasteurized milk are not statistically significant (*6*). Particular attention was paid to strontium-90 and cesium-137 in that analysis.

Practical reporting levels were developed by the participating networks, most often based on 2-standard-deviation counting errors or 2-standard-deviation total analytical errors from replicate analyses (*3*). The practical reporting level reflects analytical factors other than statistical radioactivity counting variations and will be used as a practical basis for reporting data.

The following practical reporting levels have been selected for use by all networks whose practical reporting levels were given as equal to or less than the given value.

| Radionuclide | Practical reporting level (pCi/liter) |
|---|---|
| Strontium-89 | 5 |
| Strontium-90 | 2 |
| Iodine-131 | 10 |
| Cesium-137 | 10 |
| Barium-140 | 10 |

Some of the networks gave practical reporting levels greater than those above. In these cases, the larger value is used so that only data considered by the network as meaningful will be presented. The practical reporting levels apply to the handling of individual sample determinations. The treatment of measurements equal to or below those practical reporting levels for calculation purposes, particularly in calculating monthly averages, is discussed in the data presentation.

Analytical error of precision expressed as pCi/liter or percent in a given concentration range also has been reported by the networks (*3*). The precision errors reported for each of the radionuclides fall in the following ranges:

| Radionuclide | Analytical errors of precision (2-standard deviations) |
|---|---|
| Strontium-89 | 1–5 pCi/liter for levels <50 pCi/liter; 5–10% for levels ≥50 pCi/liter; |
| Strontium-90 | 1–2 pCi/liter for levels <20 pCi/liter; 4–10% for levels ≥20 pCi/liter; |
| Iodine-131, Cesium-137, Barium-140 | 4–10 pCi/liter for levels <100 pCi/liter; 4–10% for levels ≥100 pCi/liter. |

For iodine-131, cesium-137, and barium-140, there is one exception for these precision error ranges: 25 pCi/liter at levels <100 pCi/liter for Colorado. This is reflected in the practical reporting level for the Colorado milk network.

### *Federal Radiation Council guidance applicable to milk surveillance*

In order to place the United States data on radioactivity in milk in perspective, a summary of the guidance provided by the Federal Radiation Council for specific environmental conditions was presented in the February 1973 issue of *Radiation Data and Reports.*

### *Data reporting format*

Table 2 presents the integrated results of the international, national, and State networks discussed earlier. Column 1 lists all the stations which are reported routinely in *Radiation Data and Reports.* The relationship between the PMN stations and the State stations is shown in figure 2. The first column in table 2 under each of the reported radionuclides gives the monthly average for the station and the num-

**Table 2. Concentrations of radionuclides in milk for August 1973 and 12-month period September 1972 through August 1973**

| Sampling location | | Type of sample [a] | Radionuclide concentration (pCi /liter) | | | |
|---|---|---|---|---|---|---|
| | | | Strontium-90 | | Cesium-137 | |
| | | | Monthly average [b] | 12-month average | Monthly average [b] | 12-month average |
| **UNITED STATES:** | | | | | | |
| Ala: | Montgomery [c] | P | NA | 5 | 0 | 5 |
| Alaska: | Palmer [c] | P | NA | 4 | 0 | 1 |
| Ariz: | Phoenix [c] | P | NA | 0 | 0 | 0 |
| Ark: | Little Rock [c] | P | NA | 10 | 0 | 2 |
| Calif: | Los Angeles [c] | P | NA | 0 | 0 | 0 |
| | Sacramento [c] | P | NA | 1 | 0 | 0 |
| | San Francisco [c] | P | NA | 0 | 0 | 0 |
| | Del Norte | P | 5 | 10 | 10 | 7 |
| | Fresno | P | 0 | 1 | 0 | 2 |
| | Humboldt | P | 0 | 3 | 0 | 1 |
| | Los Angeles | P | 0 | 1 | 0 | 1 |
| | Mendocino | P | 3 | 2 | 0 | 3 |
| | Sacramento | P | 0 | 2 | 0 | 3 |
| | San Diego | P | 0 | 1 | 0 | 2 |
| | Santa Clara | P | 0 | 2 | 0 | 2 |
| | Shasta | P | 0 | 2 | 0 | 3 |
| | Sonoma | P | 0 | 2 | 0 | 3 |
| Colo: | Denver [c] | P | NA | 2 | 0 | 0 |
| | East | R | NS | NA | NS | 14 |
| | Northeast | R | NS | NA | NS | 1 |
| | Northwest | R | NS | NA | NS | 0 |
| | South Central | R | NS | NS | NS | NS |
| | Southeast | R | NS | NA | NS | 0 |
| | Southwest | R | NA | NA | [d]0 | 2 |
| | West | R | NA | NA | [d]0 | 0 |
| Conn: | Hartford [c] | P | NA | 4 | 0 | 4 |
| | Central | P | NA | | NA | |
| Del: | Wilmington [c] | P | NA | 6 | 0 | 3 |
| D.C: | Washington [c] | P | NA | 4 | 0 | 1 |
| Fla: | Tampa [c] | P | NA | 4 | 28 | 30 |
| | Central | R | 5 | 5 | 54 | 35 |
| | North | R | 6 | 6 | 15 | 12 |
| | Northeast | R | 7 | 6 | 47 | 32 |
| | Southeast | R | 5 | 5 | 38 | 44 |
| | Tampa Bay area | P | 4 | 5 | 24 | 30 |
| | West | R | 10 | 8 | 12 | 8 |
| Ga: | Atlanta [c] | P | NA | 6 | 0 | 7 |
| Hawaii: | Honolulu [c] | P | NA | 1 | 0 | 0 |
| Idaho: | Idaho Falls [c] | P | NA | 3 | 0 | 0 |
| Ill: | Chicago [c] | P | NA | 5 | 0 | 2 |
| Ind: | Indianapolis [c] | P | NA | 5 | 0 | 3 |
| | Central | P | 4 | 7 | 0 | 8 |
| | Northeast | P | 5 | 5 | 15 | 9 |
| | Northwest | P | 6 | 7 | 10 | 9 |
| | Southeast | P | 6 | 7 | 15 | 6 |
| | Southwest | P | 7 | 7 | 0 | 9 |
| Iowa: | Des Moines [c] | P | NA | 5 | 0 | 0 |
| | Des Moines | P | 4 | 5 | 0(3) | 0 |
| | Iowa City | P | 5 | 5 | 0 | 0 |
| | LeMars | P | 4 | 4 | 0 | 2 |
| | Little Cedar | P | 6 | 7 | 0 | 1 |
| Kans: | Wichita [c] | P | NA | 5 | 0 | 0 |
| | Coffeyville | P | 9 | 8 | 0 | 9 |
| | Dodge City | P | 5 | 4 | 0 | 6 |
| | Falls City, Nebr | R | NS | NS | NS | NS |
| | Hays | P | 9 | 9 | 0 | 5 |
| | Kansas City | P | 4 | 8 | 0 | 9 |
| | Topeka | P | 8 | 7 | 0 | 4 |
| | Wichita | P | 6 | 8 | 10 | 11 |
| Ky: | Louisville [c] | P | NA | 5 | 0 | 1 |
| La: | New Orleans [c] | P | NA | 9 | 0 | 1 |
| Maine: | Portland [c] | P | NA | 6 | 18 | 19 |
| Md: | Baltimore [c] | P | NA | 6 | 0 | 6 |
| Mass: | Boston [c] | P | NA | 6 | 11 | 16 |
| Mich: | Detroit [c] | P | NA | 6 | 0 | |
| | Grand Rapids [c] | P | NA | 8 | 0 | 1 |
| | Bay City | P | NS | 7 | NS | 1 |
| | Charlevoix | P | 6 | 7 | 0 | 4 |
| | Detroit | P | 6 | 4 | 0 | 2 |
| | Grand Rapids | P | 11 | 8 | 0 | 1 |
| | Lansing | P | 9 | 6 | 0 | 5 |
| | Marquette | P | 13 | 9 | 14 | 10 |
| | Monroe | P | 9 | 6 | 0 | 1 |
| | South Haven | P | 8 | 7 | 0 | 4 |
| Minn: | Minneapolis [c] | P | NA | 7 | 0 | 4 |
| | Bemidji | P | 11 | 7 | 28 | 14 |
| | Duluth | P | 18 | 16 | 33 | 21 |
| | Fergus Falls | P | 7 | 6 | 0 | 0 |
| | Little Falls | P | 26 | 17 | 82 | 27 |
| | Mankato | P | 4 | 4 | 0 | 0 |
| | Marshall | P | 4 | 4 | 0 | 0 |

See footnotes at end of table.

## Table 2. Concentrations of radionuclides in milk for August 1973 and 12-month period September 1972 through August 1973—continued

| Sampling location | Type of sample [a] | Radionuclide concentration (pCi/liter) | | | |
|---|---|---|---|---|---|
| | | Strontium-90 | | Cesium-137 | |
| | | Monthly average [b] | 12-month average | Monthly average [b] | 12-month average |
| **UNITED STATES:** | | | | | |
| Minn: Minneapolis | P | 9 | 9 | 0 | 0 |
| Rochester | P | 8 | 7 | 0 | 0 |
| Miss: Jackson * | P | NA | 8 | 0 | 7 |
| Mo: Kansas City * | P | NA | 4 | 0 | 0 |
| St. Louis * | P | NA | 6 | 0 | 1 |
| Mont: Helena * | P | NA | 2 | 0 | 0 |
| Nebr: Omaha * | P | NA | 3 | 0 | 0 |
| Nev: Las Vegas * | P | NA | 3 | 0 | 0 |
| N.H: Manchester * | P | NA | 7 | 0 | 10 |
| N.J: Trenton * | P | NA | 6 | 0 | 5 |
| N. Mex: Albuquerque * | P | NA | 0 | 0 | 2 |
| N.Y: Buffalo * | P | NA | 4 | 0 | 3 |
| New York City * | P | NA | 6 | 0 | 4 |
| Syracuse * | P | NA | 6 | 0 | 2 |
| Albany | P | 7 | 4 | 0 | 0 |
| Buffalo | P | 5 | 4 | 0 | 0 |
| Massena | P | 5 | 5 | 16 | 0 |
| New York City | P | 7 | 7 | 16 | 0 |
| Syracuse | P | NS | 5 | NS | 0 |
| N.C: Charlotte * | P | NA | 7 | 0 | 6 |
| N. Dak: Minot * | P | NA | 7 | 0 | 0 |
| Ohio: Cincinnati * | P | NA | 5 | 0 | 2 |
| Cleveland * | P | NA | 6 | 0 | 3 |
| Okla: Oklahoma City * | P | NA | 3 | 0 | 0 |
| Oreg: Portland * | P | NA | 4 | 0 | 1 |
| Baker | P | NA | | NA | |
| Coos Bay | P | NA | | NA | |
| Eugene | P | NA | | NA | |
| Medford | P | NA | | NA | |
| Portland composite | P | NA | | NA | |
| Portland local | P | NA | | NA | |
| Redmond | P | NA | | NA | |
| Tillamook | P | NA | | NA | |
| Pa: Philadelphia * | P | NA | 5 | 0 | 2 |
| Pittsburgh * | P | NA | 8 | 0 | 5 |
| Dauphin | P | 6 | 4 | 0 | 1 |
| Erie | P | 6 | 6 | 0 | 1 |
| Philadelphia | P | 4 | 4 | 0 | 2 |
| Pittsburgh | P | 8 | 6 | 0 | 1 |
| R.I: Providence * | P | NA | 5 | 11 | 7 |
| S.C: Charleston * | P | NA | 6 | 0 | 8 |
| Chapin | R | NS | 8 | NS | 16 |
| Clemson | R | NS | 7 | NS | 6 |
| Columbia | R | NS | 7 | NS | 10 |
| Fairfield | R | NS | 7 | NS | 16 |
| Hartsville–02 | R | NS | 6 | NS | 12 |
| Hartsville–03 | R | 16 | 17 | 13 | 15 |
| Lee County | R | NS | 8 | NS | 17 |
| Oconee County | R | 8 | 8 | 16 | 7 |
| Pickens | R | NS | 7 | NS | 5 |
| Williston | R | NS | 7 | NS | 14 |
| Winnsboro | R | NS | 8 | NS | 16 |
| S. Dak: Rapid City * | P | NA | 5 | 0 | 1 |
| Tenn: Chattanooga * | P | NA | 6 | 0 | 4 |
| Knoxville * | P | NS | | NS | |
| Memphis * | P | NA | 6 | 11 | 3 |
| Chattanooga | P | NA | 8 | 0 | 5 |
| Clinton | R | NA | 7 | 0 (2) | 6 |
| Fayetteville | R | NA | 7 | 0 (2) | 5 |
| Kingston | R | NA | 7 | 0 (2) | 0 |
| Knoxville | P | NA | 5 | 0 | 2 |
| Lawrenceburg | R | NS | 6 | NS | 3 |
| Nashville | P | NS | 6 | NS | 2 |
| Pulaski | R | NA | 6 | 0 | 1 |
| Sequoyah | R | NS | 8 | NS | 0 |
| Tex: Austin * | P | NA | 0 | 0 | 0 |
| Dallas * | P | NA | 4 | 0 | 0 |
| Amarillo | R | NA | | NA | |
| Corpus Christi | R | NA | | NA | |
| El Paso | R | NA | | NA | |
| Fort Worth | R | NA | | NA | |
| Harlingen | R | NA | | NA | |
| Houston | R | NA | | NA | |
| Lubbock | R | NA | | NA | |
| Midland | R | NA | | NA | |
| San Antonio | R | NA | | NA | |
| Texarkana | R | NA | | NA | |
| Uvalde | R | NA | | NA | |
| Wichita Falls | R | NA | | NA | |

See footnotes at end of table.

**Table 2. Concentrations of radionuclides in milk for August 1973 and 12-month period September 1972 through August 1973—continued**

| Sampling location | Type of sample [a] | Radionuclide concentration (pCi/liter) | | | |
|---|---|---|---|---|---|
| | | Strontium-90 | | Cesium-137 | |
| | | Monthly average [b] | 12-month average | Monthly average [b] | 12-month average |
| **UNITED STATES:** | | | | | |
| Utah: Salt Lake City [c] | P | NA | 2 | 0 | 1 |
| Vt: Burlington [c] | P | NA | 5 | 0 | 7 |
| Va: Norfolk [c] | P | NA | 5 | 0 | 3 |
| Wash: Seattle [c] | P | NA | 2 | 0 | 1 |
| Spokane [c] | P | NA | 4 | 0 | 0 |
| Benton County | R | NS | 1 | NS | 0 |
| Franklin County | R | 0 | 1 | 0 | 0 |
| Longview | R | 5 | 3 | 0 | 2 |
| Sandpoint, Idaho | R | 5 | 5 | 0 | 1 |
| Skagit County | R | 3 | 5 | 0 | 2 |
| W. Va: Charleston [c] | P | NA | 6 | 0 | 3 |
| Wisc: Milwaukee [c] | P | NA | 5 | 0 | 3 |
| Wyo: Laramie [c] | P | NA | 1 | 0 | 1 |
| **CANADA:** | | | | | |
| Alberta: Calgary | P | NA | | NS | |
| Edmonton | P | NA | | 16 | 14 |
| British Columbia: Vancouver | P | NA | | 16 | 14 |
| Manitoba: Winnipeg | P | NA | | NS | |
| New Brunswick: Moncton | P | NA | | 5 | 9 |
| Newfoundland: St. John's | P | NA | | 30 | 22 |
| Nova Scotia: Halifax | P | NA | | NS | |
| Ontario: Ottawa | P | NA | | 3 | 6 |
| Sault Ste. Marie | P | NA | | 16 | 17 |
| Thunder Bay | P | NA | | NS | |
| Toronto | P | NA | | 7 | 7 |
| Windsor | P | NA | | NS | |
| Quebec: Montreal | P | NA | | NS | |
| Quebec | P | NA | | NS | |
| Saskatchewan: Regina | P | NA | | NS | |
| Saskatoon | P | NA | | 6 | 8 |
| **CENTRAL AND SOUTH AMERICA:** | | | | | |
| Canal Zone: Cristobal [c] | P | NS | 0 | NS | 11 |
| Chile: Santiago | P | NS | 1 | NS | 0 |
| Colombia: Bogota | P | 5 | 1 | 0 | 0 |
| Ecuador Guayaquil | P | 7 | 1 | 0 | 0 |
| Jamaica: Mandeville | P | NS | 2 | NS | 42 |
| Puerto Rico: San Juan [c] | P | NA | 1 | 0 | 2 |
| Venezuela: Caracas | P | 2 | 1 | 0 | 2 |
| PMN network average [e] | | NA | 4 | 1 | 3 |

[a] P, pasteurized milk.
R, raw milk.

[b] When an individual sampling result was equal to or less than the practical reporting level, a value of "0" was used for averaging. Monthly averages less than the practical reporting level reflect the fact that some but not all of the individual samples making up the average contained levels greater than the practical reporting level. When more than one analysis was made in a month period, the number of samples in the monthly average is given in parentheses.

[c] Pasteurized Milk Network station. All other sampling locations are part of the State or National network.

[d] The practical reporting level for this network differs from the general ones given in the text. Sampling results for these networks were equal to or less than the following practical reporting levels:
Cesium-137: Colorado—25 pCi/liter; Oregon—15 pCi/liter.

[e] This entry gives the average radionuclide concentrations for the Pasteurized Milk Network stations denoted by footnote [c].

NA, no analysis.
NS, no sample collected.

ber of samples analyzed in that month in parentheses. When an individual sampling result is equal to or below the practical reporting level for the radionuclide, a value of zero is used for averaging. Monthly averages are calculated using the above convention. Averages which are equal to or less than the practical reporting levels reflect the presence of radioactivity in some of the individual samples greater than the practical reporting level.

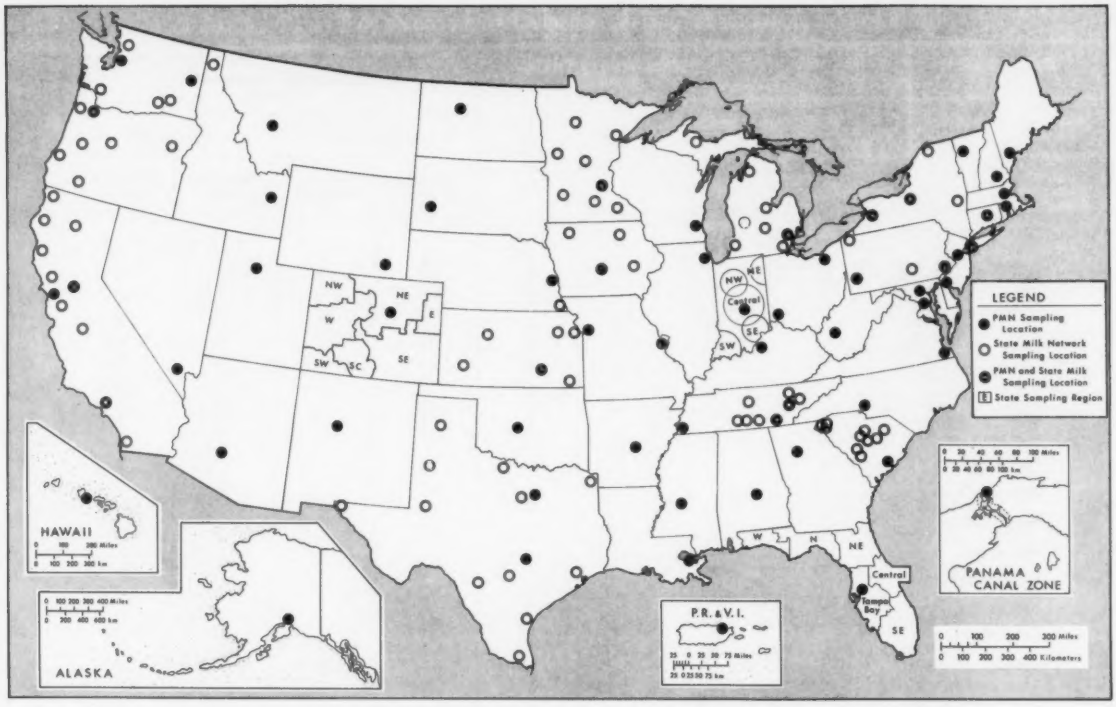


**Figure 2. State and PMN milk sampling stations in the United States**

The second column under each of the radionuclides reported gives the 12-month average for the station as calculated from the preceding 12 monthly averages, giving each monthly average equal weight. Since the daily intake of radioactivity by exposed population groups, averaged over a year, constitutes an appropriate criterion for the case where the FRC radiation protection guides apply, the 12-month average serves as a basis for comparison.

*Discussion of current data*

In table 2, surveillance results are given for strontium-90 and cesium-137 for August 1973 and the 12-month period, September 1972 to August 1973. Except where noted, the monthly average represents a single sample for the sampling station. Strontium-89 and iodine-131 data have been omitted from table 2 since levels at all of the stations for August 1973 were below the respective practical reporting levels.

Barium-140 results for individual samples were all below the practical reporting level with the following exception: Kans., Coffeyville (State) 11 pCi/liter.

Strontium-90 monthly averages ranged from 0 to 26 pCi/liter in the United States for August 1973 and the highest 12-month average was 17 pCi/liter (Little Falls, Minn., Hartsville–03, S.C.) representing 8.5 percent of the Federal Radiation Council radiation protection guide. Cesium-137 monthly averages ranged from 0 to 82 pCi/liter in the United States for August 1973, and the highest 12-month average was 44 pCi/liter (Southeast Florida) representing 1.2 percent of the value derived from the recommendations given in the Federal Radiation Council report.

The Office of Radiation Programs is in the process of modifying the milk program to make it more responsive to potential sources of environmental radioactivity. These changes will be reflected in future articles.

*Acknowledgement*

Appreciation is expressed to the personnel of the following agencies who provide data from their milk surveillance networks:

Radiologic Health Section
Environmental Control Component
California Department of Health

Radiation Protection Division
Canadian Department of National Health and Welfare

Radiological Health Section
Division of Occupational and Radiological Health
Colorado Department of Health

Laboratory Division
Connecticut Department of Health

Radiological and Occupational Health Section
Department of Health and Rehabilitative Services
State of Florida

Bureau of Environmental Sanitation
Division of Sanitary Engineering
Indiana State Board of Health

Division of Radiological Health
Environmental Engineering Services
Iowa State Department of Health

Radiation Control Section
Environmental Health Division
Kansas State Department of Health

Radiological Health Services
Division of Occupational Health
Michigan Department of Health

Radiation Control Section
Division of Environmental Health
State of Minnesota Department of Health

Bureau of Radiological Pollution Control
New York State Department of Environmental Conservation

Environmental Radiation Surveillance Program
Division of Sanitation and Engineering
Oregon State Board of Health

Radiological Health Section
Bureau of Environmental Health
Pennsylvania Department of Public Health

Division of Radiological Health
South Carolina State Board of Health

Radiological Health Services
Division of Preventable Diseases
Tennessee Department of Public Health

Division of Occupational Health
Environmental Health Services
Texas State Department of Health

Radiation Control Section
Division of Health
Washington Department of Social and Health Services

REFERENCES

(*1*) CAMPBELL, J. E., G. K. MURTHY, A. S. GOLDIN, H. B. ROBINSON, C. P. STRAUB, F. J. WEBER, and K. H. LEWIS. The occurrence of strontium-90, iodine-131, and other radionuclides in milk, May 1957 through April 1958. Amer J Pub Health 49:225 (February 1969).

(*2*) U.S. ATOMIC ENERGY COMMISSION, DIVISION OF ISOTOPES DEVELOPMENT. Chart of the Nuclides, Tenth Edition revised to December 1968. Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

(*3*) NATIONAL CENTER FOR RADIOLOGICAL HEALTH. Section I. Milk surveillance. Radiol Health Data Rep 9:730–746 (December 1968).

(*4*) ROSENSTEIN, M. and A. S. GOLDIN. Statistical technics for quality control of environmental radioassay. Health Lab Sci 2:93 (April 1965).

(*5*) BARATTA, E. J. and F. E. KNOWLES, JR. Interlaboratory study of iodine-131, cesium-137, strontium-89, and strontium-90 measurements in milk, June 1972, Technical experiment 72 MKAQ–1. Analytical Quality Control Service, Office of Radiation Programs, EPA, Washington, D.C. 20460 (December 1972).

(*6*) ROBINSON, P. B. A comparison of results between the Public Health Service Raw Milk and Pasteurized Milk Networks for January 1964 through June 1966. Radiol Health Data Rep 9:475–488 (September 1968).

# Milk Surveillance Network, August 1973

*National Environmental Research Center-Las Vegas, Environmental Protection Agency*

The Milk Surveillance Network,[1] operated by the National Environmental Research Center-Las Vegas (NERC-LV) consists of 24 routine and 2 alternate sampling locations (figure 1) situated in the offsite area surrounding the Nevada Test Site (NTS). This routine network is operated in support of the nuclear testing sponsored by the U.S. Atomic Energy Commission (AEC) at the Nevada Test Site.

In the event of a release of radioactivity from the NTS, special sampling within the affected

[1] This network is operated under a Memorandum of Understanding (No. AT(26-1)-539) with the Nevada Operations Office, U.S. AEC, Las Vegas, Nev.

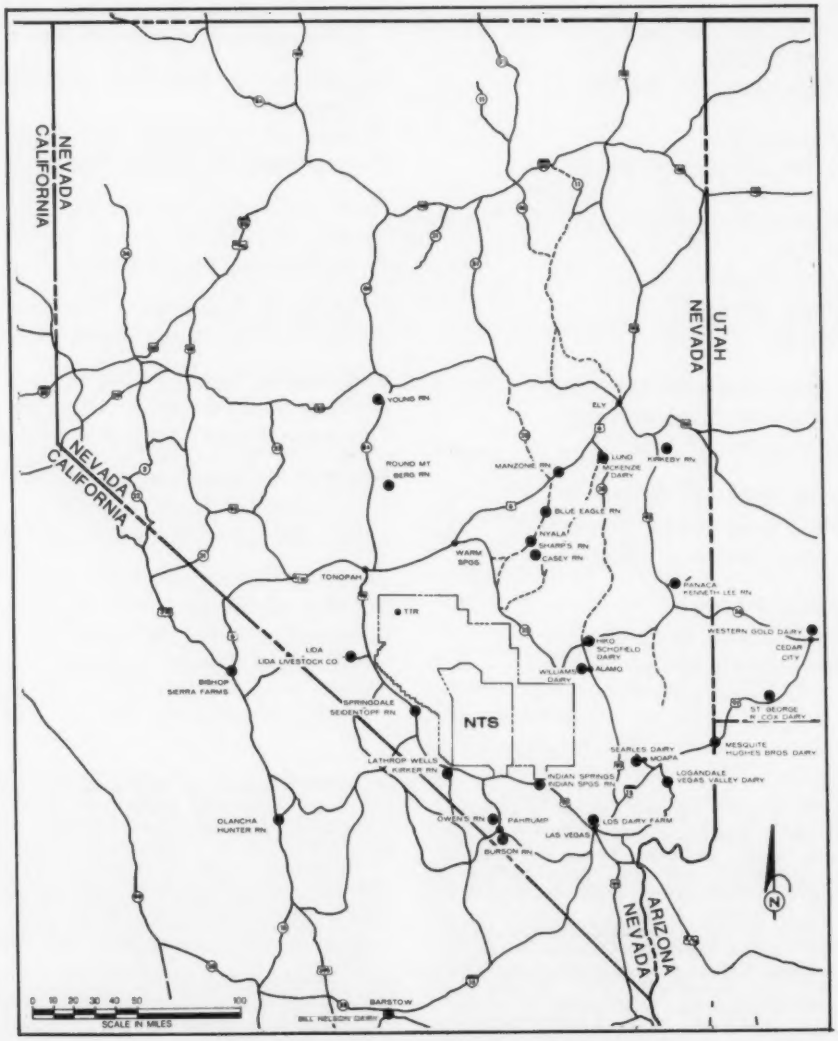


**Figure 1. NERC-LV milk surveillance network**

area is conducted to determine radionuclide concentrations. Additional milk sampling networks are operated in support of AEC operations in areas other than the NTS when requested. A complete description of sampling and analytical procedures was included with the milk results reported in the July 1973 issue of *Radiation Data and Reports.*

*Results*

The analytical results of all milk samples collected in August 1973 by NERC-LV surveillance programs are listed in table 1. Strontium-89 and -90 were not detected in any sample during this period. With the exception of cesium-137 at levels near the minimum detectable activity (MDA) of 10 pCi/liter, no gamma-emitting fission products were identified by gamma spectrometry in any of the samples collected in August. Levels of tritium near the MDA for this radionuclide (~200 pCi/liter) were also measured by liquid scintillation. The highest concentration of tritium during August 1973 was 800 ± 250 pCi/liter.

**Table 1. Milk surveillance results, August 1973**

| Location | Date collected (August 1973) | Sample type [a] | Radionuclide concentrations [b] (pCi/liter) | |
|---|---|---|---|---|
| | | | Cesium-137 | Tritium |
| California: | | | | |
| Bishop: | | | | |
| Sierra Farms | 9 | 11 | <10 | NA |
| Hinkley: | | | | |
| Bill Nelson Dairy | 7 | 12 | <10 | NA |
| Olancha: | | | | |
| Hunter Ranch | NS | 13 | | |
| Nevada: | | | | |
| Alamo: | | | | |
| Williams Dairy | 7 | 12 | <10 | NA |
| Austin: | | | | |
| Young's Ranch | 6 | 13 | <10 | 660±250 |
| Currant: | | | | |
| Blue Eagle Ranch | 14 | 13 | <10 | NA |
| Manzonie Ranch | 14 | 13 | <10 | NA |
| Hiko: | | | | |
| Schofield Dairy | 7 | 12 | <10 | 400±240 |
| Indian Springs: | | | | |
| Indian Springs Ranch | NS | | | |
| Las Vegas: | | | | |
| LDS Dairy Farms | 17 | 12 | <10 | 360±250 |
| Lathrop Wells: | | | | |
| Kirker Ranch | 9 | 13 | <10 | NA |
| Lida: | | | | |
| Lida Livestock Company | 5 | 13 | <10 | NA |
| Logandale: | | | | |
| Vegas Valley Dairy | 14 | 12 | <10 | NA |
| Lund: | | | | |
| McKenzie Dairy | 13 | 12 | <10 | 340±250 |
| Mesquite: | | | | |
| Hughes Bros. Dairy | 14 | 12 | <10 | 350±250 |
| Moapa: | | | | |
| Searles Dairy | 13 | 12 | <10 | NA |
| Nyala: | | | | |
| Sharp's Ranch | 7 | 13 | * <100 | 800±250 |
| Pahrump: | | | | |
| Owens Ranch | 8 | 13 | <10 | NA |
| Panaca: | | | | |
| Kenneth Lee Ranch | 8 | 13 | <10 | NA |
| Round Mountain: | | | | |
| Berg Ranch | 6 | 13 | <10 | NA |
| Shoshone: | | | | |
| Kirkeby Ranch | NS | | | |
| Springdale: | | | | |
| Seidentopf Ranch | 7 | 13 | <10 | NA |
| Utah: | | | | |
| Cedar City: | | | | |
| Western Gold Dairy | 15 | 12 | <10 | NA |
| St. George: | | | | |
| R. Cox Dairy | 14 | 12 | <10 | NA |

[a] 11—pasteurized milk.
12—raw milk from Grade A producer(s).
13—raw milk from family cow(s).
[b] Two-sigma counting error provided when available.
* Small sample size increased minimum detectable activity.
NA, no analysis.
NS, no sample.

## Food and Diet Surveillance

Efforts are being made by various Federal and State agencies to estimate the dietary intake of selected radionuclides on a continuing basis. These estimates, along with the guidance developed by the Federal Radiation Council, provide a basis for evaluating the significance of radioactivity in foods and diet.

Networks presently in operation and reported routinely include those listed below. These networks provide data useful for developing estimates of nationwide dietary intakes of radionuclides. Programs reported in *Radiation Data and Reports* are as follows:

| Program | Period reported | Issue |
|---|---|---|
| California Diet Study | January–June 1971 | December 1972 |
| Carbon-14 in total Diet and Milk | 1972–1973 | November 1973 |
| Institutional Diet | January–March 1973 | November 1973 |

## Radiostrontium in Milk, January–December 1972[1]

*Health and Safety Laboratory*
*U.S. Atomic Energy Commission*

In 1954, the Health and Safety Laboratory began monitoring for strontium-90 in liquid whole milk to estimate the dietary contribution from the ingestion of the radionuclide from this source.

The New York City sample is a monthly composite of pasteurized milk purchased daily at retail stores. Five main dairies are represented in the sample. The powdered milk sampling at Perry, N.Y. was terminated at the end of 1969.

The strontium-90 to calcium ratios for New York for January–December 1972 are presented in table 1.

[1] Data summarized from "Fallout Program Quarterly Summary Report, October 1, 1973." HASL-276. Available from National Technical Information Service, 5285 Port Royal Road, Springfield, Va. 22151.

Previous coverage *in Radiation Data and Reports:*

| Period | Issue |
|---|---|
| January–December 1971 | November 1972 |

**Table 1. Strontium-90 to calcium ratios in milk, January-December 1972**

| Sampling location | Strontium-90 to calcium ratio (pCi/g) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |
| New York, N.Y. (liquid whole milk) | 5.9 | 5.5 | 5.6 | 6.1 | 7.7 | 7.3 | 7.7 | 6.0 | 5.0 | 6.2 | 6.4 | 5.4 |

# Strontium-90 in Tri-City Diets, January–December 1972

*Health and Safety Laboratory*
*U.S. Atomic Energy Commission*

Estimates of the average intake of strontium-90 by New York City, Chicago, and San Francisco residents have been made by the Health and Safety Laboratory (*HASL*). These estimates were made by using measurements of the strontium-90 content of a large variety of foods purchased at the cities every 3 months and statistics on the average consumption of each food compiled by the U.S. Department of Agriculture in their 1955 Household Diet Survey (*1*). A detailed description of the aims and methods of the *HASL* diet sampling program along with a summary of the results obtained during the first 3 years of operation (1960–1963) was published earlier (*2*).

In 1968, two changes were made in the program. The first change was the suspension of the collection and analysis of foods purchased in Chicago. Previous experience had shown the levels of strontium-90 in the Chicago diet to be consistently between those of New York City and San Francisco. Thus, reasonable estimates of the dietary intake of strontium-90 in Chicago at any time can be made from the analyses of foods purchased in New York City and San Francisco.

The second change, revision of the estimates of the annual consumption of different diet components, was made because new information became available. This new information on the composition of the diet appeared in a preliminary report of the U.S. Department of Agriculture in their 1965 Household Diet Survey (*3*). The changes in the composition of the diet from 1955 to 1965 are not very great, and the estimates of strontium-90 intake using statistics from either diet survey are not

[1] Data from Fallout Program Quarterly Summary Report, HASL 257, 259 and 273. Available from the Clearinghouse for Federal Scientific and Technical Information, CFSTI, 5285 Port Royal Road, Springfield, Va. 22151.

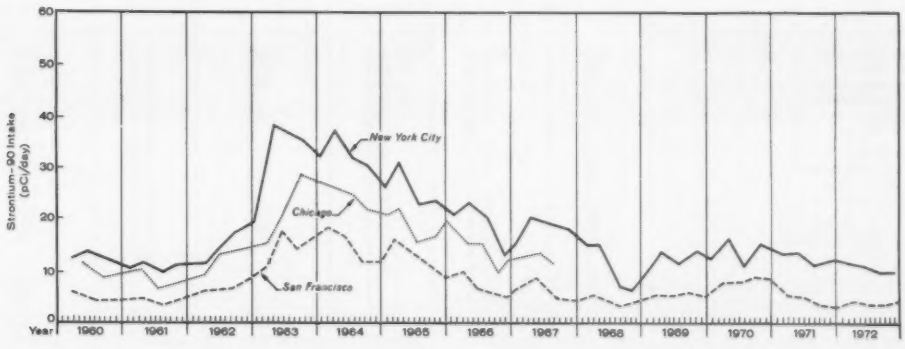


**Figure 1. Daily intake of strontium-90 in tri-city diets, 1960–December 1972**

**Table 1. Average dietary consumption and strontium-90 intake in Tri-City diet, January-March 1972**

| Food category | Diet (kg/a) | Calcium (g/a) | Strontium-90 | | | |
|---|---|---|---|---|---|---|
| | | | New York City February 1972 | | San Francisco March 1972 | |
| | | | (pCi/kg) | (pCi/a) | (pCi/kg) | (pCi/a) |
| Dairy products | 200 | 216.0 | 6.8 | 1,351 | 1.7 | 344 |
| Fresh fruit | 59 | 9.4 | 15.8 | 930 | 3.9 | 228 |
| Fresh vegetables | 48 | 18.7 | 12.2 | 585 | 5.4 | 258 |
| Root vegetables | 10 | 3.8 | 11.4 | 114 | 6.7 | 67 |
| Potatoes | 38 | 3.8 | 8.6 | 328 | 2.0 | 78 |
| Macaroni | 3 | .6 | 4.2 | 13 | 3.5 | 11 |
| Rice | 3 | 1.1 | 1.8 | 5 | 1.5 | 4 |
| Fruit juices | 28 | 2.5 | 3.4 | 96 | 3.5 | 97 |
| Canned vegetables | 22 | 4.4 | 7.9 | 174 | 3.6 | 79 |
| Canned fruit | 11 | .6 | 1.3 | 14 | .9 | 10 |
| Dried beans | 3 | 2.1 | 19.5 | 58 | 10.2 | 31 |
| Flour | 34 | 6.5 | 6.1 | 206 | 3.3 | 111 |
| Bakery products | 44 | 53.7 | 6.4 | 283 | 3.3 | 147 |
| Whole grain products | 11 | 10.7 | 12.0 | 132 | 6.6 | 72 |
| Fresh fish | 8 | 7.6 | .5 | 4 | ND | |
| Shellfish | 1 | 1.6 | 1.2 | 1 | .8 | 1 |
| Poultry | 20 | 6.0 | .5 | 10 | .3 | 7 |
| Meat | 79 | 12.6 | .7 | 54 | .4 | 29 |
| Eggs | 15 | 8.7 | 1.6 | 24 | 1.4 | 21 |
| Annual intake (pCi/a) | | 370 | | 4,382 | | 1,595 |
| Daily intake (pCi/g Ca) | | | | 11.8 | | 4.3 |

ND, nondetectable.

too different. Estimates of the intakes of other nuclides, however, may be affected to a greater degree. The new estimates of the consumption have therefore been used to calculate the intakes of calcium and strontium-90 for 1971 in New York City and San Francisco.

Results for January–December 1972 are presented in tables 1 through 4. The variation with time of the daily intake of strontium-90 in the three cities is plotted in figure 1.

**Table 2. Average dietary consumption and strontium-90 intake in Tri-City diet, April-June 1972**

| Food category | Diet (kg/a) | Calcium (g/a) | Strontium-90 | | | |
|---|---|---|---|---|---|---|
| | | | New York City May 1972 | | San Francisco June 1972 | |
| | | | (pCi/kg) | (pCi/a) | (pCi/kg) | (pCi/a) |
| Dairy products | 200 | 216.0 | 8.2 | 1,635 | 1.5 | 290 |
| Fresh fruit | 59 | 9.4 | 9.5 | 559 | 2.6 | 151 |
| Fresh vegetables | 48 | 18.7 | 16.6 | 798 | 2.7 | 131 |
| Root vegetables | 10 | 3.8 | 5.0 | 50 | 2.7 | 27 |
| Potatoes | 38 | 3.8 | 6.4 | 242 | 1.5 | 57 |
| Macaroni | 3 | .6 | 4.2 | 13 | 3.7 | 11 |
| Rice | 3 | 1.1 | 1.2 | 4 | 1.5 | 5 |
| Fruit juices | 28 | 2.5 | 2.6 | 73 | 1.6 | 44 |
| Canned vegetables | 22 | 4.4 | 7.7 | 170 | 4.3 | 94 |
| Canned fruit | 11 | .6 | 1.0 | 11 | 1.3 | 14 |
| Dried beans | 3 | 2.1 | 5.0 | 15 | 12.4 | 37 |
| Flour | 34 | 6.5 | 4.7 | 159 | 4.4 | 149 |
| Bakery products | 44 | 53.7 | 5.6 | 246 | 3.0 | 134 |
| Whole grain products | 11 | 10.3 | 10.3 | 114 | 6.1 | 67 |
| Fresh fish | 8 | 7.6 | .5 | 4 | ND | |
| Shellfish | 1 | 1.6 | 1.3 | 1 | ND | |
| Poultry | 20 | 6.0 | .4 | 9 | .5 | 10 |
| Meat | 79 | 12.6 | .4 | 35 | .4 | 35 |
| Eggs | 15 | 8.7 | 1.7 | 25 | 1.2 | 17 |
| Annual intake (pCi/a) | | 370 | | 4,163 | | 1,273 |
| Daily intake (pCi/g Ca) | | | | 11.3 | | 3.4 |

ND, nondetectable.

**Table 3. Average dietary consumption and strontium-90 intake in Tri-City diet, July-September 1972**

| Food category | Diet (kg/a) | Calcium (g/a) | Strontium-90 | | | |
|---|---|---|---|---|---|---|
| | | | New York City August 1972 | | San Francisco September 1972 | |
| | | | (pCi/kg) | (pCi/a) | (pCi/kg) | (pCi/a) |
| Dairy products | 200 | 216.0 | 5.9 | 1,173 | 1.2 | 240 |
| Fresh fruit | 59 | 9.4 | 7.0 | 413 | 2.1 | 121 |
| Fresh vegetables | 48 | 18.7 | 13.0 | 623 | 1.1 | 53 |
| Root vegetables | 10 | 3.8 | 6.0 | 60 | 3.8 | 38 |
| Potatoes | 38 | 3.8 | 7.4 | 281 | 1.3 | 48 |
| Macaroni | 3 | .6 | 4.7 | 14 | 4.1 | 12 |
| Rice | 3 | 1.1 | 1.7 | 5 | 1.8 | 6 |
| Fruit juices | 28 | 2.5 | 3.5 | 98 | 2.1 | 59 |
| Canned vegetables | 22 | 4.4 | 5.6 | 122 | 2.2 | 49 |
| Canned fruit | 11 | .6 | 1.5 | 16 | .8 | 9 |
| Dried beans | 3 | 2.1 | 14.5 | 44 | 4.4 | 13 |
| Flour | 34 | 6.5 | 6.8 | 232 | 3.4 | 115 |
| Bakery products | 44 | 53.7 | 6.6 | 292 | 2.5 | 111 |
| Whole grain products | 11 | 10.3 | 11.6 | 128 | 4.3 | 48 |
| Fresh fish | 8 | 7.6 | .4 | 3 | ND | ---- |
| Shell fish | 1 | 1.6 | .2 | ---- | ND | ---- |
| Poultry | 20 | 6.0 | .5 | 10 | .4 | 8 |
| Meat | 79 | 12.6 | .5 | 40 | .5 | 36 |
| Eggs | 15 | 8.7 | 2.8 | 41 | 1.4 | 22 |
| Annual intake (pCi/a) | | 370 | | 3,595 | | 988 |
| Daily intake (pCi/g Ca) | | | | 9.7 | | 2.7 |

ND, nondetectable.

**Table 4. Average dietary consumption and strontium-90 intake in Tri-City diet October-December 1972**

| Food category | Diet (kg/a) | Calcium (g/a) | Strontium-90 | | | |
|---|---|---|---|---|---|---|
| | | | New York City November 1972 | | San Francisco December 1972 | |
| | | | (pCi/kg) | (pCi/a) | (pCi/kg) | (pCi/a) |
| Dairy products | 200 | 216.0 | 6.7 | 1,331 | 1.5 | 290 |
| Fresh fruit | 59 | 9.4 | 8.0 | 475 | 2.3 | 137 |
| Fresh vegetables | 48 | 18.7 | 14.1 | 678 | 2.4 | 113 |
| Root vegetables | 10 | 3.8 | 6.3 | 63 | 5.7 | 57 |
| Potatoes | 38 | 3.8 | 4.1 | 155 | 3.8 | 143 |
| Macaroni | 3 | .6 | 4.2 | 13 | 4.4 | 13 |
| Rice | 3 | 1.1 | 1.3 | 4 | 1.3 | 4 |
| Fruit juices | 28 | 2.5 | 2.8 | 80 | 2.1 | 60 |
| Canned vegetables | 22 | 4.4 | 7.6 | 166 | 3.1 | 69 |
| Canned fruit | 11 | .6 | 1.2 | 13 | 1.2 | 13 |
| Dried beans | 3 | 2.1 | 10.4 | 31 | 29.9 | 90 |
| Flour | 34 | 6.5 | 6.4 | 216 | *3.5 | 118 |
| Bakery products | 44 | 53.7 | 3.4 | 150 | 3.2 | 141 |
| Whole grain products | 11 | 10.3 | 9.8 | 108 | 5.0 | 55 |
| Fresh fish | 8 | 7.6 | ND | ---- | ND | ---- |
| Shell fish | 1 | 1.6 | 1.0 | 1 | ND | ---- |
| Poultry | 20 | 6.0 | .6 | 11 | .8 | 16 |
| Meat | 79 | 12.6 | ND | ---- | .5 | 40 |
| Eggs | 15 | 8.7 | .3 | 4 | 1.1 | 16 |
| Annual intake (pCi/a) | | 370 | | 3,499 | | 1,375 |
| Daily intake (pCi/g Ca) | | | | 9.5 | | 3.7 |

* Estimated.
ND, nondetectable.

## REFERENCES


(1) U.S. DEPARTMENT OF AGRICULTURE. Food consumption of households in the United States, household food consumption survey, Report No. 1 (1955). Superintendent of Documents, Government Printing Office, Washington, D.C. 20402 (December 1956).

(2) RIVERA, J. and J. H. HARLEY. HASL contributions to the study of fallout in food chains, HASL-137. Office of Technical Services, U.S. Atomic Energy Commission, New York, N.Y. (July 1, 1964).

(3) U.S. DEPARTMENT OF AGRICULTURE. Food consumption of households in the United States, spring 1965, A Preliminary Report. USDA, ARS 62–16 (August 1967).

# SECTION II. WATER

The Environmental Protection Agency and other Federal, State, and local agencies operate extensive water quality sampling and analysis programs for surface, ground, and treated water. Most of these programs include determinations of gross beta and gross alpha radioactivity and specific radionuclides.

Although the determination of the total radionuclide intake from all sources is of primary importance, a measure of the public health importance of radioactivity levels in water can be obtained by comparison of the observed values with the Public Health Service Drinking Water Standards (*1*). These standards, based on consideration of Federal Radiation Council (FRC) recommendations (*2–4*) set the limits for approval of a drinking water supply containing radium-226 and strontium-90 at 3 pCi/liter and 10 pCi/liter, respectively. Higher concentrations may be acceptable if the total intake of radioactivity from all sources remains within the guides recommended by FRC for control action. In the known absence[1] of strontium-90 and alpha-particle emitters, the limit is 1,000 pCi/liter of gross beta radioactivity, except when additional analysis indicates that concentrations of radionuclides are not likely to cause exposures greater than the limits indicated by the Radiation Protection Guides. Surveillance data from a number of Federal and State programs are published periodically to show current and long-range trends. Water sampling activities reported in *Radiation Data and Reports* are listed below.

[1] Absence is taken to mean a negligibly small fraction of the specific limits of 3 pCi/liter and 10 pCi/liter for unidentified alpha-particle emitters and strontium-90, respectively.

| Water sampling program | Period reported | Issue |
|---|---|---|
| California | January–December 1971 and 1972 | November 1973 |
| Colorado River Basin | 1968 | March 1972 |
| Community Water Supply Study | 1968 | September 1972 |
| Florida | 1969 | January 1972 |
| Interstate Carrier Drinking Water | 1971 | May 1972 |
| Kansas | January–December 1971 | February 1973 |
| Michigan | January–June 1970 | November 1971 |
| Minnesota | July 1970–June 1971 | November 1972 |
| New York | July–December 1971 | August 1973 |
| North Carolina | 1968–1970 | September 1972 |
| Tritium Surveillance System | April–June 1973 | October 1973 |
| Washington | July 1970–June 1971 | August 1973 |
| Water Surveillance Programs, *NERC-LV* | June–July 1973 | November 1973 |

REFERENCES

(*1*) U.S. PUBLIC HEALTH SERVICE. Drinking water standards, revised 1962, PHS Publication No. 956. Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 (March 1963).

(*2*) FEDERAL RADIATION COUNCIL. Radiation Protection Guidance for Federal Agencies, Memorandum for the President, September 1961. Reprint from the Federal Register of September 26, 1961.

(*3*) FEDERAL RADIATION COUNCIL. Background material for the development of Radiation Protection Standards, Report No. 1. Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 (May 1960).

(*4*) FEDERAL RADIATION COUNCIL. Background material for the development of Radiation Protection Standards, Report No. 2. Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 (September 1961).

# Water Surveillance Programs, August 1973

*National Environmental Research Center-Las Vegas, Environmental Protection Agency*

The Water Surveillance Network, operated by the National Environmental Research Center-Las Vegas (NERC-LV), consists of 59 sampling locations (figures 1 and 2) in the offsite area surrounding the Nevada Test Site (NTS). This routine network is operated in support of the nuclear testing programs sponsored by the U.S. Atomic Energy Commission (AEC) at the Nevada Test Site.[1]

In the event of a release of radioactivity from the NTS, special sampling within the affected

[1] This network is operated under a Memorandum of Understanding (No. AT(26-1)-539) with the Nevada Operations Office, U.S. AEC, Las Vegas, Nev.

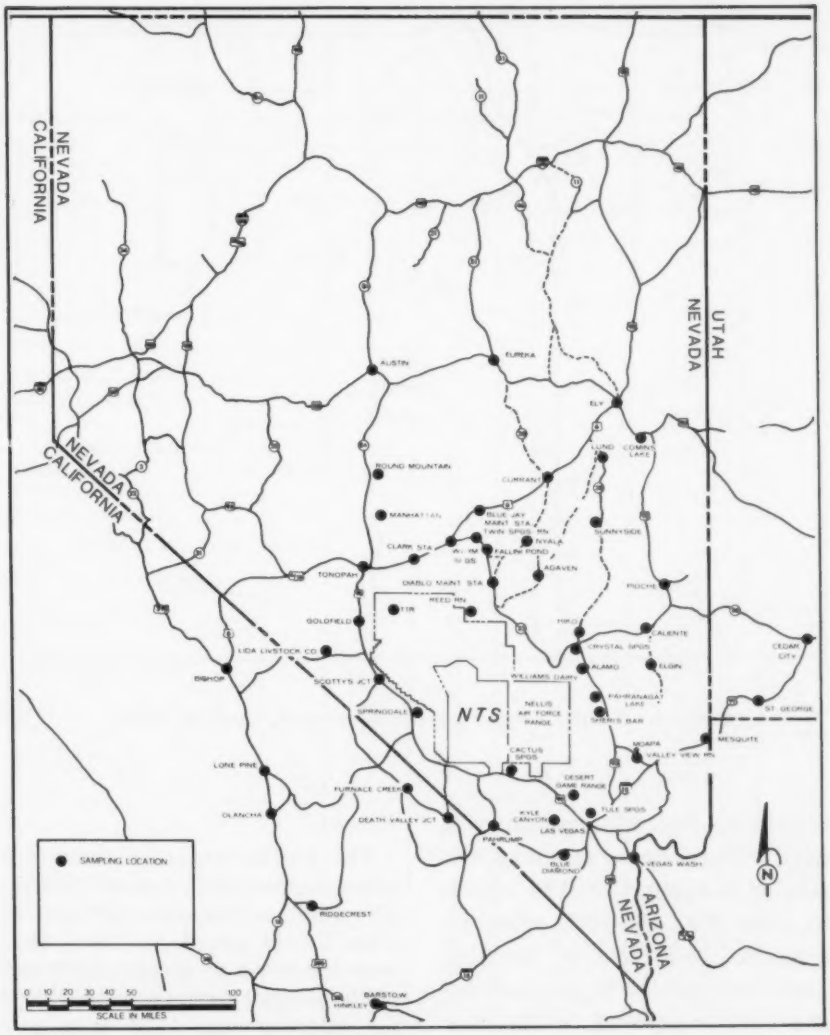


**Figure 1. NERC-LV water surveillance network**

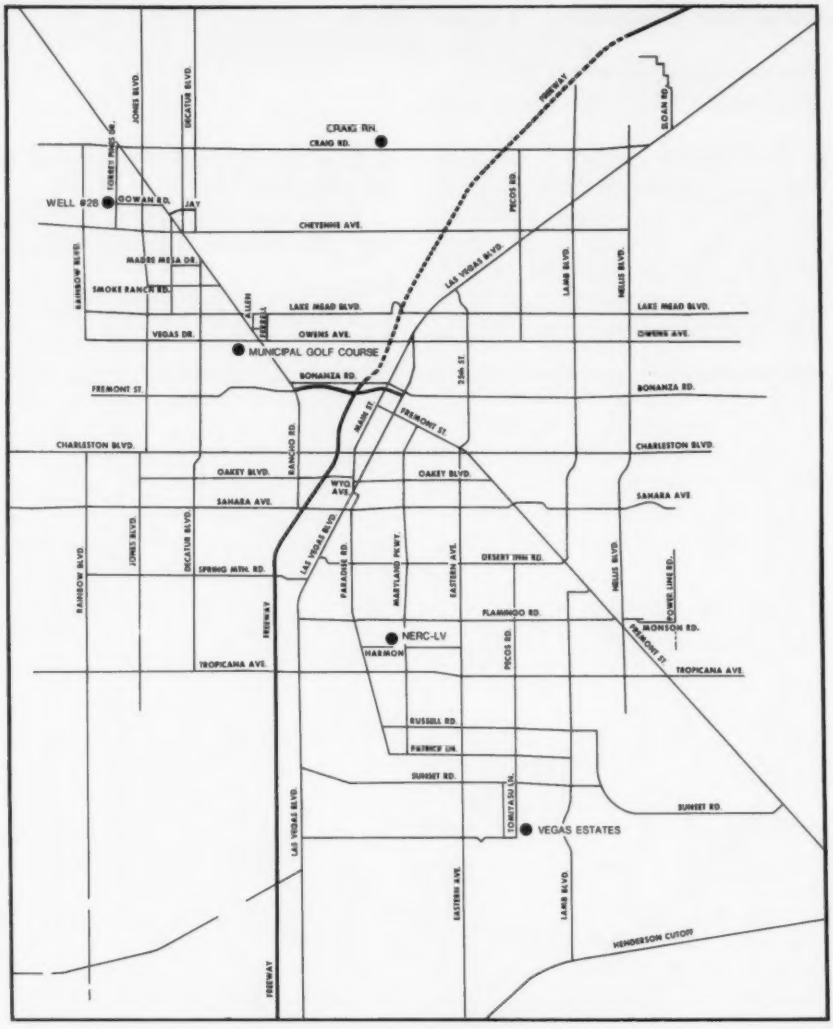


**Figure 2. NERC-LV water surveillance network, Las Vegas valley**

areas is conducted to determine radionuclide concentrations. Additional water sampling networks are operated in support of AEC operations in areas other than the NTS when requested. A complete description of sampling and routine analytical procedures was included with the water results reported in the July 1973 issue of *Radiation Data and Reports*.

*Results*

The routine analytical results of all water samples collected in August 1973 by the NERC-LV water surveillance network are listed in table 1. No gamma-emitting fission products were identified by gamma spectrometry in any of the August samples. The analytical results for calendar year 1973 samples selected for special analyses will be reported at a later date.

## Table 1. Water surveillance results, August 1973

| Location | Date collected (August 1973) | Sample type [a] | Radionuclide concentrations [b] (pCi/liter) | | |
|---|---|---|---|---|---|
| | | | Gross alpha | Gross beta | Tritium |
| **California:** | | | | | |
| Bishop: | | | | | |
| Fish and Game Office | 9 | 23 | <1.6 | <3.5 | NA |
| Death Valley Junction: | | | | | |
| Lila's Cafe | NS | 23 | | | |
| Furnace Creek: | | | | | |
| Pond | 10 | 21 | <3.0 | <3.6 | NA |
| Visitor's Center | 10 | 27 | <2.4 | 7.8±3.8 | NA |
| Hinkley: | | | | | |
| Bill Nelson Dairy | 7 | 23 | 5.7±4.6 | 4.2±3.6 | NA |
| Lone Pine: | | | | | |
| Forest Service Ranger Station | 8 | 24 | <1.3 | <3.5 | NA |
| Olancha: | | | | | |
| Haiwee Reservoir | 7 | 21 | <1.3 | <3.5 | NA |
| Ridgecrest: | | | | | |
| City Hall | 7 | 23 | <3.4 | <3.5 | NA |
| **Nevada:** | | | | | |
| Adaven: | | | | | |
| Canfield Ranch | 7 | 22 | <2.3 | <3.4 | NA |
| Alamo: | | | | | |
| Pahranagat Lake | 7 | 21 | 14 ±6.8 | 22 ±4.6 | NA |
| Sheri's Bar | 7 | 23 | <2.7 | <3.5 | NA |
| Williams Dairy | 7 | 23 | 5.0±4.3 | 10 ±4.0 | NA |
| Austin: | | | | | |
| Nevada National Bank | 5 | 27 | 20 ±5.8 | 6.0±3.5 | NA |
| Blue Diamond: | | | | | |
| Post Office | 1 | 23 | 3.9±3.7 | <3.5 | <240 |
| Blue Jay Highway: | | | | | |
| Maintenance Station | 9 | 23 | 3.3±3.2 | <3.4 | NA |
| Cactus Springs: | | | | | |
| Mobil Service Station | 6 | 27 | <2.0 | <3.3 | 290±240 |
| Caliente: | | | | | |
| Agricultural Extension Station | 9 | 23 | 4.3±3.2 | <3.3 | NA |
| Clark Station: | | | | | |
| Five Mile Ranch | 9 | 27 | <1.6 | 5.7±3.5 | NA |
| Currant: | | | | | |
| Currant Ranch Cafe | 14 | 27 | <3.0 | 4.9±3.5 | NA |
| Diablo: | | | | | |
| Highway Maintenance Station | 7 | 23 | 3.2±3.0 | 8.0±3.6 | NA |
| Reed Ranch | 6 | 21 | 19 ±6.7 | 8.1±3.7 | NA |
| Elgin: | | | | | |
| Water tower | 9 | 23 | 4.8±4.2 | 5.9±3.7 | NA |
| Ely: | | | | | |
| Chevron Service Station | 13 | 24 | 3.7±2.6 | <3.3 | NA |
| Comins Lake | 13 | 21 | 7.7±4.9 | 26 ±4.6 | NA |
| Eureka: | | | | | |
| Highway Maintenance Station | 1 | 24 | 9.4±4.5 | <3.5 | NA |
| Goldfield: | | | | | |
| Chevron Service Station | 6 | 23 | <2.6 | <3.5 | NA |
| Hiko: | | | | | |
| Crystal Springs | 7 | 27 | 5.7±3.6 | <3.5 | NA |
| Schofield Dairy | 7 | 23 | 33 ±9.3 | 25 ±4.7 | NA |
| Las Vegas: | | | | | |
| Craig Ranch Golf Course | 13 | 23 | 3.4±3.0 | <3.5 | <240 |
| Desert Game Range | 13 | 24 | <2.4 | <3.3 | <240 |
| Lab II NERC | 13 | 24 | <3.7 | 4.6±3.7 | 830±250 |
| Lake Mead Vegas wash | 13 | 21 | <4.2 | 6.8±3.7 | 870±250 |
| Las Vegas Water District well 28 | 13 | 23 | 3.9±2.9 | <3.3 | <240 |
| Municipal Golf Course | 13 | 23 | <1.9 | <3.3 | <240 |
| Tule Springs | 13 | 23 | 3.4±2.7 | <3.3 | <240 |
| Tule Springs Pond | 13 | 21 | <1.6 | <3.3 | NA |
| Vegas Estates | 13 | 23 | 5.2±4.9 | 9.5±4.0 | 260±240 |
| Lida: | | | | | |
| Lida Livestock Company | 6 | 27 | <2.4 | <3.5 | NA |
| Pond at storage tank | 6 | 21 | 4.5±3.4 | 8.0±3.6 | NA |
| Lund: | | | | | |
| Gardner Grocery | 13 | 23 | 2.8±2.7 | <3.3 | NA |
| Manhattan: | | | | | |
| Country store | 7 | 23 | 14 ±6.4 | 3.9±3.5 | NA |
| Mesquite: | | | | | |
| Hughes Bros. Dairy | 14 | 23 | <3.4 | 4.9±3.6 | NA |
| Moapa: | | | | | |
| Pedersen Valley View Ranch | 14 | 27 | 5.3±4.6 | 11 ±3.9 | NA |
| Mt. Charleston: | | | | | |
| Kyle Canyon Fire Station | 13 | 27 | <1.9 | <3.3 | <240 |
| Nyala: | | | | | |
| Sharp's Ranch | 7 | 23 | 3.4±2.7 | <3.3 | NA |
| Pahrump: | | | | | |
| Texaco Service Station | 8 | 23 | 4.3±3.0 | <3.3 | NA |
| Pioche: | | | | | |
| County courthouse | 8 | 24 | 2.8±2.6 | <3.5 | NA |

See footnotes at end of table.

**Table 1. Water surveillance results, August 1973—continued**

| Location | Date collected (August 1973) | Sample type [a] | Radionuclide concentrations [b] (pCi/liter) | | |
|---|---|---|---|---|---|
| | | | Gross alpha | Gross beta | Tritium |
| Round Mountain: | | | | | |
| Mobil Service Station | 7 | 27 | 4.0±3.0 | <3.3 | NA |
| Scotty's Junction: | | | | | |
| Chevron Service Station | 6 | 23 | 6.9±5.1 | 7.7±3.8 | 360±230 |
| Springdale: | | | | | |
| Pond | 7 | 21 | <4.1 | 7.5±3.7 | NA |
| Sunnyside: | | | | | |
| Adam McGill Reservoir | 13 | 21 | <2.7 | 3.5±3.4 | NA |
| Wildlife Management Headquarters | 13 | 27 | <2.1 | <3.3 | NA |
| Tonopah: | | | | | |
| Jerry's Chevron Station | 8 | 23 | 4.3±3.2 | 4.8±3.6 | NA |
| Tonopah Test Range CP-1 | 8 | 23 | 4.6±3.6 | 4.5±3.5 | NA |
| Warm Springs: | | | | | |
| Fallini's Pond | NS | 21 | | | |
| Service Station and Cafe | 9 | 27 | 20 ±8.5 | 25 ±4.7 | NA |
| Twin Springs Ranch | 9 | 23 | 5.1±3.8 | 5.6±3.5 | NA |
| Utah: | | | | | |
| Cedar City: | | | | | |
| M. D. Baldwin Residence | 15 | 24 | <1.3 | <3.3 | NA |
| St. George: | | | | | |
| R. Cox Dairy | 14 | 24 | 2.4±1.8 | <3.3 | NA |

[a] 21—Pond, lake, reservoir, stock tank, stock pond.
22—Stream, river, creek.
23—Well.
24—Multiple supply mixed (a water sample consisting of mixed or multiple sources of water such as well and spring).
27—Spring.

[b] Two-sigma counting error provided when available.
NA, not analyzed.
NS, no sample.

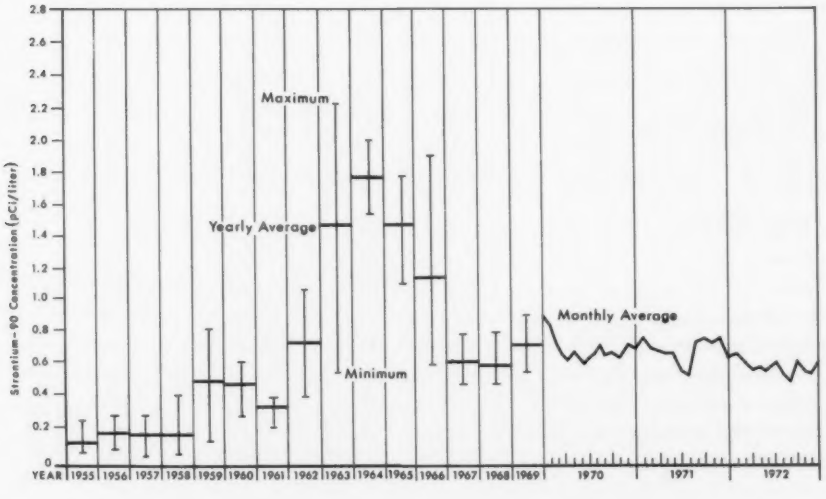


**Figure 1. Strontium-90 concentration in New York City tap water 1955–December 1972**

# Radiostrontium in Tap Water, January–December 1972[1]

*Health and Safety Laboratory*
*U.S. Atomic Energy Commission*

The Health and Safety Laboratory has performed analyses for strontium-90 in tap water of New York City since August 1954. Samples of tap water are collected daily so that by the end of the month a composite of at least 100 liters is available for analysis. Cesium-137 determinations were begun in January 1964. The analytical methods used at the laboratory are given in the Health and Safety Laboratory Manual of Standard Procedures (*1*).

Strontium-90 concentrations and cesium-137 to strontium-90 ratios in New York City tap water for January through December 1972 are presented in table 1. These results appear graphically in figure 1.

A decreasing trend has been observed in the strontium-90 concentrations since the July 1963 peak. The maximum strontium-90 concentrations observed are below the acceptable limit as set forth in the interstate carrier drinking water standards (*2*).

**Table 1. Radiostrontium in New York City tap water January-December 1972**

| Month (1972) | Strontium-90[a] (pCi/liter) | Cesium-137/ strontium-90 |
|---|---|---|
| January | 0.65 | 0.12 |
| February | .59 | .11 |
| March | .54 | .10 |
| April | .56 | .08 |
| May | .54 | .10 |
| June | .59 | .10 |
| July | .51 | .10 |
| August | .46 | (b) |
| September | .60 | (b) |
| October | .54 | (b) |
| November | .53 | .09 |
| December | .60 | .07 |

[a] Approximately 100 liters per sample.
[b] No cesium-137 analysis.

## REFERENCES

(*1*) U.S. ATOMIC ENERGY COMMISSION. Manual of standard procedures 40:E–38–01–16. Health and Safety Laboratory, U.S. Atomic Energy Commission, 376 Hudson Street, New York, N.Y. 10014.

(*2*) FEDERAL REGISTER RULES AND REGULATIONS. Title 42–Public Health, Chapter 1, Public Health Service, Department of Health, Education, and Welfare; Part 72, Interstate Quarantine, Subpart J, Drinking Water Standards 27:2154–2155. Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 (March 6, 1962).

Previous coverage in *Radiation Data and Reports:*

| Period | Issue |
|---|---|
| July–December 1971 | November 1972 |

[1] Prepared from information appearing in Fallout Program Quarterly Summary Report, HASL–276 (October 1, 1973). This report is available from the National Technical Information Service, 5285 Port Royal Road, Springfield, Va. 22151.

# SECTION III. AIR AND DEPOSITION

## Radioactivity in Airborne Particulates and Precipitation

Continuous surveillance of radioactivity in air and precipitation provides one of the earliest indications of changes in environmental fission product radioactivity. To date, this surveillance has been confined chiefly to gross beta radioanalysis. Although such data are insufficient to assess total human radiation exposure from fallout, they can be used to determine when to modify monitoring in other phases of the environment.

Surveillance data from a number of programs are published monthly and summarized periodically to show current and long-range trends of atmospheric radioactivity in the Western Hemisphere. These include data from activities of the Environmental Protection Agency, the Canadian Department of National Health and Welfare, the Pan American Health Organization, and the California Air Sampling Program.

In addition to those programs presented in this issue, the following programs were covered previously in *Radiation Data and Reports.*

| Network | Period | Issue |
|---|---|---|
| Fallout in the United States and other areas | 1971 | August 1973 |
| Plutonium in airborne particulates | October–December 1972 | June 1973 |
| Surface air sampling program, 80th Meridian Network, *HASL* | January–December 1971 | September 1973 |

## 1. Radiation Alert Network August 1973

*Eastern Environmental Radiation Facility*
*Environmental Protection Agency*

Surveillance of atmospheric radioactivity in the United States is conducted by the Radiation Alert Network (RAN) which gathers samples at 68 locations distributed throughout the country (figure 1). Most of the stations are operated by State health department personnel.

The station operators perform "field estimates" on the airborne particulate samples at 5 hours after collection, when most of the radon daughter products have decayed, and at 29 hours after collection, when most of the thoron daughter products have decayed. The airborne particulate samples and precipitation samples are sent to the Eastern Environmental Radiation Facility for further analysis. All field estimate results are reported to appropriate Environmental Protection Agency officials by mail or telephone depending on levels found. A compilation of the daily measurements is available upon request from the Eastern Environmental Radiation Facility, Montgomery, Ala. 36109. A detailed description of the sampling and analytical procedures was presented in the March 1968 issue of *Radiological Health Data and Reports.*

Table 1 presents the monthly average gross beta radioactivity in surface air particulates and deposition by precipitation, as measured by the field estimate and laboratory techniques during August 1973.

The Office of Radiation Programs is in the process of modifying the air program to make it more responsive to potential sources of environmental radioactivity. These changes will be reflected in future articles.


**Figure 1. Radiation Alert Network sampling stations**

**Table 1. Gross beta radioactivity in surface air and precipitation, August 1973**

| Station location | Number of samples | Gross beta radioactivity (pCi/m³) | | | | | | Precipitation | |
|---|---|---|---|---|---|---|---|---|---|
| | | 5-hour field estimate | | | Laboratory measurement | | | Laboratory estimate of deposition | |
| | | Maximum | Minimum | Average[a] | Maximum | Minimum | Average[a] | Depth (mm) | Total deposition (nCi/m²) |
| Ala: Montgomery | 23 | 3 | 0 | 1 | 0.03 | 0.01 | 0.02 | 90 | 0.26 |
| Alaska: Anchorage | 2 | 0 | 0 | 0 | .02 | <.01 | .01 | | |
| Calif: Berkeley | 9 | 0 | 0 | 0 | .01 | <.01 | <.01 | | |
| Los Angeles | 9 | 1 | 0 | 0 | .05 | .02 | .03 | | |
| Colo: Denver | 9 | 2 | 1 | 2 | .06 | .03 | .04 | 12 | .14 |
| Del: Dover | 17 | 1 | 0 | 0 | .07 | .01 | .03 | | |
| Ind: Indianapolis | 22 | 2 | 0 | 1 | .04 | .02 | .03 | | |
| Nev: Las Vegas | 22 | 3 | 1 | 2 | .08 | <.01 | .04 | | |
| N. Mex: Santa Fe | 4 | 1 | 1 | 1 | .03 | .01 | .02 | 50 | .20 |
| N.Y: Buffalo | 9 | 1 | 0 | 1 | .06 | .02 | .04 | | |
| N. Dak: Bismarck | 9 | 2 | 1 | 1 | .05 | .01 | .03 | 5 | .05 |
| Ohio: Columbus | 8 | 3 | 0 | 1 | .05 | .03 | .04 | | |
| Okla: Oklahoma City | 7 | 2 | 0 | 1 | .04 | .02 | .03 | | |
| Oreg: Portland | 23 | 0 | 0 | 0 | .02 | <.01 | .01 | | |
| Pa: Harrisburg | 22 | 3 | 0 | 1 | .06 | <.01 | .03 | | |
| S.C: Columbia | 8 | 3 | 0 | 1 | .05 | .03 | .04 | 165 | .87 |
| Utah: Salt Lake City | 13 | 3 | 0 | 2 | .05 | .02 | .04 | | |
| Network summary | 216 | 3 | 0 | 1 | 0.08 | <0.01 | 0.03 | 64 | 0.30 |

[a] The monthly average is calculated by weighting the measurements of individual air samples with length of sampling period.

## 2. Air Surveillance Network, August 1973

*National Environmental Research Center-Las Vegas*[1]
*Environmental Protection Agency*

The Air Surveillance Network[2] (ASN), operated by the National Environmental Research Center-Las Vegas (NERC-LV), consists of 49 active and 72 standby sampling stations located in 21 Western States (figures 2 and 3). The network is operated in support of nuclear testing sponsored by the U.S. Atomic Energy Commission (AEC) at the Nevada Test Site (NTS), and at any other designated testing sites.

The stations are operated by State Health department personnel and by private individuals on a contract basis. All active stations are operated continuously with filters being exchanged over periods generally ranging from 24 to 72 hours. All samples are mailed to the NERC-LV unless special retrieval is arranged at selected locations in response to known releases of radioactivity from the NTS. A complete description of sampling and analytical procedures was presented in the February 1972 issue of *Radiation Data and Reports.*

### *Results*

Table 2 presents the average gross beta concentrations in air for each of the network stations. The minimum reporting concentration for gross beta activity is 0.1 pCi/m³. For reporting purposes, concentrations less than 1.0 pCi/m³ are reported to 1 significant figure, and those equal to or greater than 1.0 pCi/m³ are reported to 2 significant figures. For averaging purposes individual concentration values less than the minimum detectable concentration (~0.06 pCi/m³ for a 350 m³ sample) are set equal to the minimum detectable concentration (MDC). Reporting and rounding-off conventions are indicated as follows:

[1] Formerly the Western Environmental Research Laboratory.
[2] The ASN is operated under a Memorandum of Understanding (No. AT(26-1)-539) with the Nevada Operations Office, U.S. Atomic Energy Commission.

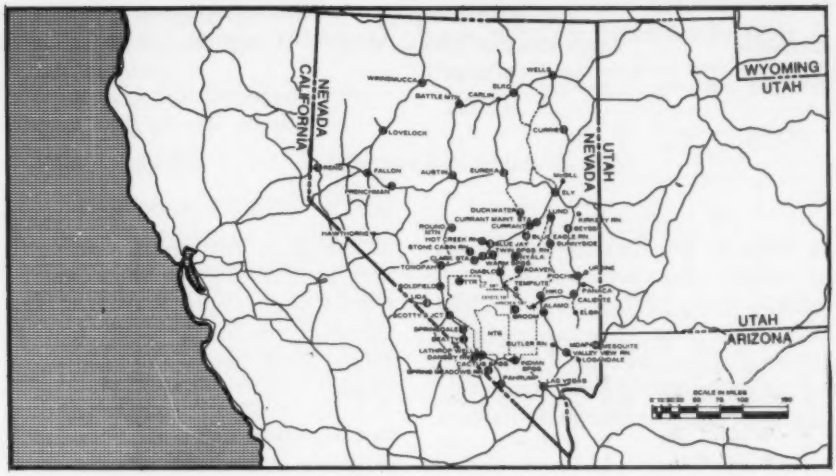


**Figure 2. NERC-LV air surveillance network stations in Nevada**


**Figure 3. NERC-LV air surveillance network stations outside Nevada**

| Concentration (pCi/m³) | Reported value of concentration above MDC (pCi/m³) | Reported value of concentration below MDC (pCi/m³) |
|---|---|---|
| <0.05 | < 0.1 | <0.1 |
| ≧ .05 <0.15 | .1 | < .1 |
| ≧ .15 | As calculated and rounded | calculated MDC |

As shown by table 2, the highest gross beta concentration within the network was 0.3 pCi/m³ at Fallini's Twin Springs Ranch, Hiko and Scotty's Junction, Nev. No radionuclides were identified by gamma spectrometry on any filters or charcoal cartridges during August.

Complete copies of this summary and listings of the daily gross beta and gamma spectrometry results are distributed to EPA Regional Offices and appropriate State agencies. Additional copies of the daily results may be obtained from the NERC-LV upon written request.

**Table 2. Summary of gross beta radioactivity concentration in air August 1973**

| Location | | Number of samples | Concentration (pCi/m³) | | |
|---|---|---|---|---|---|
| | | | Maximum | Minimum | Average |
| Ariz: | Kingman | 31 | 0.2 | <0.1 | 0.1 |
| | Seligman | 31 | .2 | <.1 | .1 |
| Calif: | Baker | 27 | .1 | <.1 | .1 |
| | Barstow | 31 | .1 | <.1 | .1 |
| | Bishop | 31 | .2 | <.1 | .1 |
| | Death Valley Junction | 31 | .1 | <.1 | .1 |
| | Furnace Creek | 31 | .2 | <.1 | .1 |
| | Lone Pine | 27 | .1 | <.1 | .1 |
| | Needles | 28 | .1 | <.1 | .1 |
| | Ridgecrest | 31 | .1 | <.1 | .1 |
| | Shoshone | 25 | .1 | <.1 | .1 |
| Nev: | Alamo | 30 | .2 | <.1 | .1 |
| | Austin | 24 | .1 | <.1 | .1 |
| | Beatty | 30 | .2 | <.1 | .1 |
| | Blue Eagle Ranch (Currant) | 27 | .2 | <.1 | .1 |
| | Blue Jay | 31 | .2 | <.1 | .1 |
| | Caliente | 31 | .2 | <.1 | .1 |
| | Currant Ranch | 31 | .2 | <.1 | .1 |
| | Diablo | 31 | .1 | <.1 | .1 |
| | Duckwater | 28 | .2 | <.1 | .1 |
| | Ely | 28 | .1 | <.1 | .1 |
| | Eureka | 31 | .1 | <.1 | .1 |
| | Fallini's Twin Springs Ranch | 31 | .3 | <.1 | .1 |
| | Geyser Ranch (Pioche) | 27 | .2 | <.1 | .1 |
| | Goldfield | 28 | <.2 | <.1 | .1 |
| | Groom Lake | 21 | .2 | <.1 | .1 |
| | Hiko | 31 | .3 | <.1 | .1 |
| | Indian Springs | 31 | .1 | <.1 | .1 |
| | Las Vegas | 22 | .2 | <.1 | .1 |
| | Lathrop Wells | 31 | .1 | <.1 | .1 |
| | Lida | 31 | .1 | <.1 | .1 |
| | Lund | 31 | .1 | <.1 | .1 |
| | Mesquite | 31 | .2 | <.1 | .1 |
| | Nyala | 31 | .1 | <.1 | .1 |
| | Pahrump | 31 | .2 | <.1 | .1 |
| | Pioche | 31 | .1 | <.1 | .1 |
| | Round Mountain | 31 | .1 | <.1 | .1 |
| | Scotty's Junction | 28 | .3 | <.1 | .1 |
| | Stone Cabin Ranch | 31 | .1 | <.1 | .1 |
| | Sunnyside | 31 | .2 | <.1 | .1 |
| | Tonopah | 31 | .1 | <.1 | .1 |
| | Tonopah Test Ranch | 18 | .2 | <.1 | .1 |
| | Warm Springs | 29 | .2 | <.1 | .1 |
| | Warm Springs Ranch | 31 | .1 | <.1 | .1 |
| Utah: | Bryce Canyon | 15 | <.1 | <.1 | .1 |
| | Cedar City | 17 | .1 | <.1 | .1 |
| | Delta | 28 | <.2 | <.1 | .1 |
| | Garrison | 31 | .2 | <.1 | .1 |
| | Milford | 30 | .1 | <.1 | .1 |
| | St. George | 31 | .1 | <.1 | .1 |

## 3. Canadian Air and Precipitation Monitoring Program,[3] August 1973

*Radiation Protection Division*
*Department of National Health and Welfare*

The Radiation Protection Division of the Canadian Department of National Health and Welfare monitors surface air and precipitation in connection with its Radioactive Fallout Study Program. Twenty-four collection stations are located at airports (figure 4), where the sampling equipment is operated by personnel from the Meteorological Services Branch of the Department of Transport. Detailed discussions of the sampling procedures, methods of analysis, and interpretation of results of the radioactive fallout program are contained in reports of the Department of National Health and Welfare (*1–5*).

A summary of the sampling procedures and methods of analysis was presented in the May 1969 issue of *Radiological Health Data and Reports.*

[3] Prepared from information and data obtained from the Canadian Department of National Health and Welfare, Ottawa, Canada.

Surface air and precipitation data for August 1973 are presented in table 3.

**Table 3. Canadian gross beta radioactivity in surface air and precipitation, August 1973**

| Location | Number of samples | Air surveillance gross beta radioactivity (pCi/m³) | | | Precipitation measurements | |
|---|---|---|---|---|---|---|
| | | Maximum | Minimum | Average | Average concentration (pCi/liter) | Total deposition (nCi/m²) |
| Calgary | 4 | 0.02 | 0.01 | 0.01 | 6.8 | 0.5 |
| Coral Harbour | 3 | .06 | .01 | .02 | 6.0 | .4 |
| Edmonton | 4 | .02 | .01 | .01 | 4.1 | 4.8 |
| Ft. Churchill | 3 | .01 | <.01 | .01 | 34.6 | 1.9 |
| Fredericton | 3 | .01 | .01 | .01 | 5.5 | 1 |
| Goose Bay | 3 | .01 | .01 | .01 | 3.1 | .2 |
| Halifax | 4 | .02 | .01 | .01 | 3.9 | .4 |
| Inuvik | 4 | .01 | <.01 | .01 | 8.9 | .4 |
| Montreal | 4 | .02 | <.01 | .01 | 11.8 | 1 |
| Moosonee | 4 | .02 | .01 | .01 | 18 | .7 |
| Ottawa | 3 | .04 | .01 | .02 | 10.5 | 1.1 |
| Quebec | 4 | .02 | .01 | .01 | NS | NS |
| Regina | 4 | .03 | .02 | .01 | 27.6 | .9 |
| Resolute | 3 | .01 | <.01 | .01 | 16.6 | .4 |
| St. John's, Nfld. | 3 | .01 | .01 | .01 | NS | NS |
| Saskatoon | 4 | .02 | .01 | .01 | NS | NS |
| Sault Ste. Marie | 4 | .03 | .02 | .01 | 9.4 | 1 |
| Thunder Bay | 4 | .02 | .01 | .01 | 9 | 1.2 |
| Toronto | 3 | .02 | .01 | .01 | 2.1 | .1 |
| Vancouver | 4 | .01 | .01 | .01 | NS | NS |
| Whitehorse | 4 | .04 | <.01 | .01 | NS | NS |
| Windsor | NS | | | | 36.2 | 1.7 |
| Winnipeg | 4 | .02 | .02 | .01 | 10.5 | .7 |
| Yellowknife | 4 | .01 | <.01 | <.01 | 6 | .8 |
| Network summary | 84 | 0.06 | <0.01 | 0.01 | 12 | 1.0 |

NS, no sample.

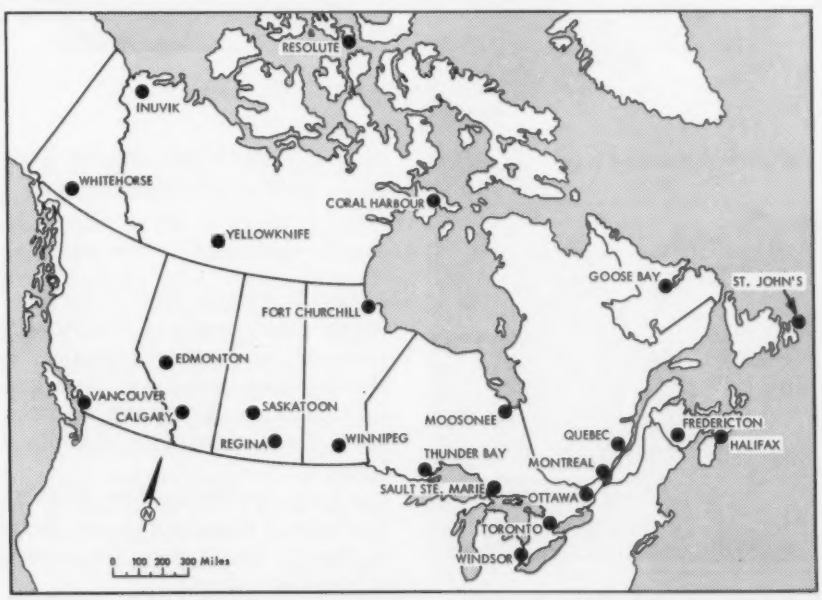


**Figure 4. Canadian air and precipitation sampling stations**

## 4. Pan American Air Sampling Program August 1973

*Pan American Health Organization and U.S. Environmental Protection Agency*

Gross beta radioactivity in air is monitored by countries in the Americas under the auspices of the collaborative program developed by the Pan American Health Organization (PAHO) and the Environmental Protection Agency (EPA) to assist PAHO-member countries in developing radiological health programs.

The air sampling station locations are shown in figure 5. Analytical techniques were described in the March 1968 issue of *Radiological Health Data and Reports*. The August 1973 air monitoring results from the participating countries are given in table 4.


**Figure 5. Pan American Air Sampling Program stations**

**Table 4. Summary of gross beta radioactivity in Pan American surface air, August 1973**

| Station location | | Number of samples | Gross beta radioactivity (pCi/m³) | | |
|---|---|---|---|---|---|
| | | | Maximum | Minimum | Average[a] |
| Argentina: | Buenos Aires | 0 | | | |
| Bolivia: | La Paz | 16 | 1.4 | 0.01 | 0.07 |
| Chile: | Santiago | 30 | 9.2 | .00 | .86 |
| Colombia: | Bogota | 21 | .04 | .00 | .01 |
| Ecuador: | Cuenca | 22 | .83 | .00 | .07 |
| | Guayaquil | 21 | 6.1 | .00 | .97 |
| | Quito | 4 | .01 | .00 | .00 |
| Guyana: | Georgetown | 0 | | | |
| Jamaica: | Kingston | 0 | | | |
| Peru: | Lima | 15 | 13.5 | .04 | 2.22 |
| Venezuela: | Caracas | 16 | .08 | .00 | .02 |
| West Indies: | Trinidad | 10 | .16 | .02 | .07 |
| Pan American summary | | 155 | 13.5 | 0.00 | 0.54 |

[a] The monthly average is calculated by weighting the individual samples with length of sampling period. Values less than 0.005 pCi/m³ are reported and used in averaging as 0.00 pCi/m³.

## 5. California Air Sampling Program August 1973

*Radiologic Health Section*
*California Department of Health*

The Radiologic Health Section of the California Department of Health with the assistance of several cooperating agencies and organizations operates a surveillance system for determining radioactivity in airborne particulates. The air sampling locations are shown in figure 6.

All air samples are sent to the Sanitation and Radiation Laboratory of the State Department of Health where they are analyzed for their radioactive content.

Airborne particules are collected by a con-


**Figure 6. California air sampling program stations**

tinuous sampling of air filtered through a 47 millimeter membrane filter, 0.8 micron pore size, using a Gast air pump of about 2 cubic feet per minute capacity, or 81.5 cubic meters per day. Air volumes are measured with a direct reading gas meter. Filters are replaced every 24 hours except on holidays and weekends. The filters are analyzed for gross alpha and beta radioactivity, 72 hours after the end of the collection period. The daily samples then are composited into a monthly sample for gamma spectroscopy and an analysis for strontium-89 and strontium-90. Table 5 presents the monthly gross beta radioactivity in air for August 1973. The monthly sample results are presented quarterly.

**Table 5. Gross beta radioactivity in California air August 1973**

| Station location | Number of samples | Gross beta radioactivity (pCi/m³) | | |
|---|---|---|---|---|
| | | Maximum | Minimum | Average |
| Bakersfield | 31 | 1.12 | 0.08 | 0.29 |
| Barstow | 31 | .75 | .06 | .20 |
| Berkeley | 31 | .07 | .00 | .03 |
| El Centro | 26 | 1.23 | .01 | .18 |
| Eureka | 29 | .13 | .00 | .03 |
| Fresno | 31 | 1.21 | .06 | .16 |
| Los Angeles | 30 | .21 | .00 | .06 |
| Redding | 31 | .46 | .07 | .16 |
| Sacramento | 31 | .51 | .02 | .11 |
| Salinas | 31 | 3.23 | .00 | .25 |
| San Bernardino | 31 | .98 | .00 | .17 |
| San Diego | 30 | .31 | .02 | .08 |
| San Luis Obispo | 31 | .54 | .03 | .12 |
| Santa Rosa | 27 | .20 | .00 | .06 |
| Summary | 421 | 3.23 | 0.00 | 0.13 |

## 6. Mexican Air Monitoring Program January–June 1973

*Instituto Nacional de Energía Nuclear*
*México, D.F.*

The Radiation Surveillance Network of Mexico is operated by the Instituto Nacional de Energía Nuclear (INEN).

In the Instituto Nacional de Energía Nuclear, the Comité de Seguridad Radiológica (Radiological Security Committee) (CSR) is responsible for radiological protection. The Environmental Radioactivity Section (Sección de Radioactividad Ambiental) of the CSR is in charge of monitoring and measuring environmental radioactive contamination in general, including radiation in mines, uranium milling plant, and the Nuclear Center of Mexico.

Since radioactivity in air particulates have decreased to very low levels in the past few years, the objective of the air monitoring program has been changed from an alert type of network to emphasize dose assessment.

Measurements will continue in the following 6 areas: México City, D.F., Chihuahua, Ensenada, Torreón, Veracruz, and Mérida (figure 7). The sampling and analysis procedures were described previously (*6*).

The maximum, minimum, and average beta radioactivity in surface air from January through June 1973 are presented in table 6. Statistically, it has been found that a minimum of five samples per month was needed to get a reliable average radioactivity at each station (*7*).


**Figure 7. Mexican air sampling locations**

**Table 6. Mexican gross beta radioactivity of airborne particulates January-June 1973[a]**

| Station | Gross beta radioactivity (pCi/m³) | | | | | |
|---|---|---|---|---|---|---|
| | January | February | March | April | May | June |
| Chihuahua: | | | | | | |
| Maximum | 0.32 | 0.15 | <0.2 | <0.2 | 0.17 | 0.10 |
| Minimum | .04 | .04 | <.2 | <.2 | .04 | .04 |
| Average | .11 | .07 | <.2 | <.2 | .08 | .07 |
| Ensenada: | | | | | | |
| Maximum | NS | NS | <.2 | <.2 | NS | .13 |
| Minimum | NS | NS | <.2 | <.2 | NS | <.03 |
| Average | NS | NS | <.2 | <.2 | NS | .07 |
| Mérida: | | | | | | |
| Maximum | .1 | .16 | <.2 | <.2 | .11 | .07 |
| Minimum | .05 | .08 | <.2 | <.2 | .04 | .04 |
| Average | .07 | .11 | <.2 | <.2 | .07 | .06 |
| México, D.F: | | | | | | |
| Maximum | .05 | .08 | <.6 | <.2 | .10 | NS |
| Minimum | NS | .04 | <.2 | <.2 | .04 | NS |
| Average | [b] | .05 | <.2 | [b] | .07 | [b] |
| Torreon: | | | | | | |
| Maximum | .16 | .12 | <.2 | <.2 | .10 | .09 |
| Minimum | .11 | .05 | <.2 | <.2 | .05 | .03 |
| Average | .12 | .08 | <.2 | <.2 | .08 | .06 |
| Veracruz: | | | | | | |
| Maximum | .09 | .10 | <.2 | <.2 | .11 | .11 |
| Minimum | <.03 | .06 | <.2 | <.2 | .05 | <.03 |
| Average | .05 | .07 | <.2 | <.2 | .07 | .06 |

[a] Due to a change in counting equipment, the minimum detectable activity for January, February, May, and June was 0.03 pCi/m³ ±50 percent error at the 95-percent confidence level. During March and April, the minimum detectable activity was 0.02 pCi/m³ ±50 percent error at the 95-percent confidence level.

[b] Average not calculated for less than five samples.

NS, no sample.

## REFERENCES


(1) BIRD, P. M., A. H. BOOTH, and P. G. MAR. Annual report of 1959 on the Radioactive Fallout Study Program, CNHW–RP–3. Department of National Health and Welfare, Ottawa, Canada (May 1960).

(2) BIRD, P. M., A. H. BOOTH, and P. G. MAR. Annual report for 1960 on the Radioactive Fallout Study Program, CNHW–RP–4. Department of National Health and Welfare, Ottawa, Canada (December 1961).

(3) MAR, P. G. Annual report for 1961 on the Radioactive Fallout Study Program, CNHW–RP–5. Department of National Health and Welfare, Ottawa, Canada (December 1962).

(4) BEALE, J. and J. GORDON. The operation of the Radiation Protection Division Air Monitoring Program, RPD–11. Department of National Health and Welfare, Ottawa, Canada (July 1962).

(5) BOOTH, A. H. The calculation of permissible levels of fallout in air and water and their use in assessing the significance of 1961 levels in Canada, RPD–21. Department of National Health and Welfare, Ottawa, Canada (August 1962).

(6) INSTITUTO NACIONAL DE ENERGIA NUCLEAR. Mexican air monitoring program, August–December 1970 and January 1971. Radiol Health Data Rep 12:525–528 (October 1971).

(7) VASQUEZ, M. and R. M. DE NULMAN. Estudios sobre la radioactividad ambiental en la Republica Mexicana, 1963–1965. Comision Nacional de Energía Nuclear, Direccion General de Seguridad Radiológica (1966).

# SECTION IV. OTHER DATA

This section presents results from routine sampling of biological materials and other media not reported in the previous sections. Included here are such data as those obtained from human bone sampling, Alaskan surveillance, and environmental monitoring around nuclear facilities.

## Environmental Levels of Radioactivity at Atomic Energy Commission Installations

The U.S. Atomic Energy Commission (AEC) receives from its contractors annual reports on the environmental levels of radioactivity in the vicinity of major Commission installations. The reports include data from routine monitoring programs where operations are of such a nature that plant environmental surveys are required.

Releases of radioactive materials from AEC installations are governed by radiation standards set forth by AEC's Division of Operational Safety in directives published in the "AEC Manual." [1]

Summaries of the environmental radioactivity data follow for the National Reactor Testing Station and the Oak Ridge Area.

[1] Title 10, Code to Federal Regulations, Part 20, "Standards for Protection Against Radiation" contains essentially the standards published in Chapter 0524 of the AEC Manual.

### 1. National Reactor Testing Station[2] January–December 1970

*Health Services Laboratory*
*U.S. Atomic Energy Commission*
*Idaho Falls, Idaho*

The National Reactor Testing Station (NRTS) was established in 1949 by the U.S. Atomic Energy Commission (AEC) to promote reactor development by building, testing, and operating various types of nuclear reactors, allied plants, and equipment. By 1970, 49 reactors had been built at the NRTS and 16 were still operating or operable.

The NRTS is situated on a desert plain in southeastern Idaho at an average elevation of 4,865 feet. The station is comprised of 571,800 acres of sagebrush and basalt fields and the boundary stretches 39 miles from north to south and about 36 miles wide in its broader southern part. The nearest NRTS boundaries are 29 miles west of Idaho Falls, 32 miles northwest of Blackfoot, 50 miles northwest of Pocatello, and 7 miles southeast of Arco, Idaho (figure 1).

Although annual precipitation in the NRTS areas has averaged only 8.5 inches, underlying the desert plain is a huge natural underground reservoir of water in the basaltic lava rock. The lateral flow of this water is about one billion gallons per day. Aquifer water is supplied principally from the North Fork of the Snake River. Additional water comes from the Big and Little Lost Rivers and Birch Creek, which start in the mountains to the north and sink into the porous soils of the NRTS area. The underground water seeps slowly at a rate of 10-20 feet per day to the south and west, emerging in numerous springs along the Snake River between Milner and Bliss, Idaho.

Major programs currently underway at the NRTS fall into five major categories. One program provides test irradiation services from

[2] Summarized from "National Reactor Testing Station, Environmental Monitoring Program Report" January–December 1970. U.S. Atomic Energy Commission, Idaho Operations Office, Health Services Laboratory.

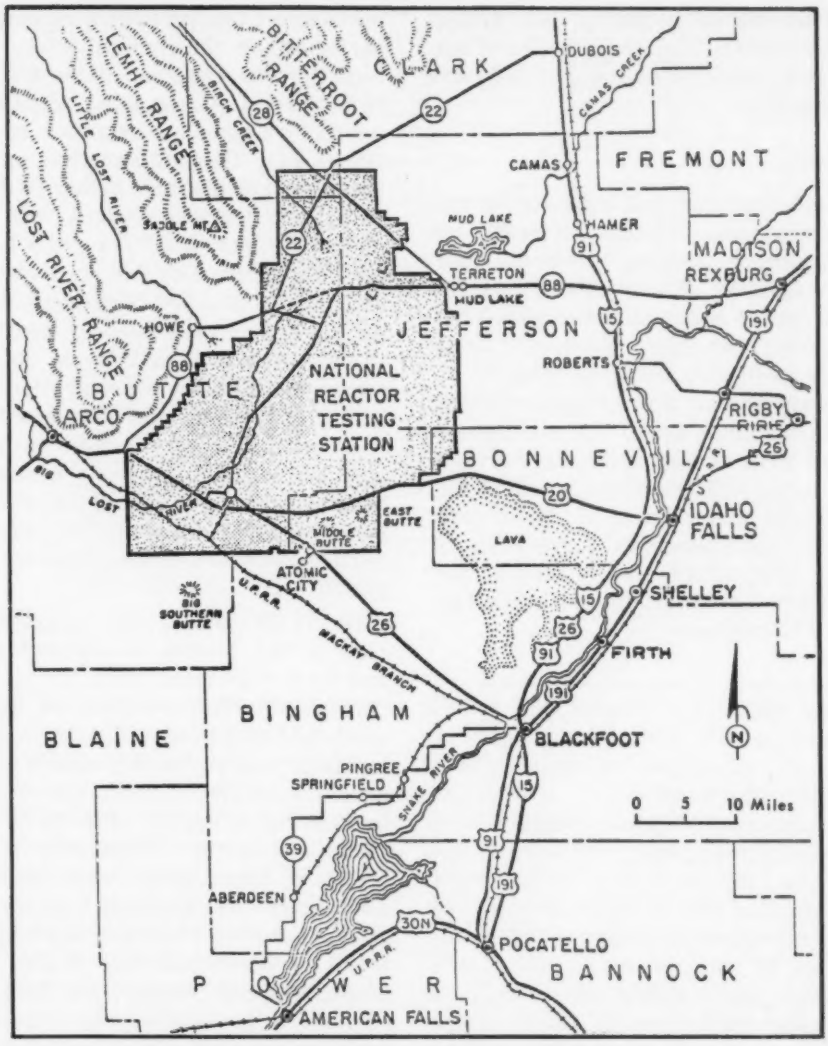


**Figure 1. National Reactor Testing Station environs**

the two operating high-flux test reactors, the ETR and ATR. Another program operates the Idaho Chemical Processing Plant (ICPP) for recovery of uranium from highly enriched spent fuels. A third major program is that of light-water-cooled reactor safety testing and research. The Loss-of-Fluid Test (LOFT) and the Power Burst Facility (PBF) are the important projects in the reactor safety program. Other significant programs include the operation of the Experimental Breeder Reactor II (EBR–II) by Argonne National Laboratory and the operation of the Naval Reactor Facility (NRF).

Because of these activities, small amounts of radioactivity were released to the atmosphere and the Snake River Plain aquifer. In its environmental monitoring program, the Health Services Laboratory (HSL) of the AEC measured the levels of radioactivity in air and ground water samples and measured the gamma radiation exposure at onsite locations, commu-

nities near the NRTS boundary, and distant background locations. The concentration of suspended airborne particulates and dust fall rates also were measured.

*Air monitoring*

Air samplers were operated continuously and drew air through sets of filters for weekly periods. A membrane prefilter (Gelman Model VM–4) for collection of particulates was followed by an in-line activated charcoal-impregnated cellulose fiber filter (Gelman Model AC–1) for removal of radioiodine from the air stream. An average air flow of approximately 1 cubic foot per minute (cfm) was maintained. Air samplers were located onsite, in the small towns close to the NRTS perimeter, and at distant background sites (figure 2). These locations provided comprehensive surveillance of atmospheric radioactivity and theoretically made it possible to differentiate worldwide fallout from NRTS releases.

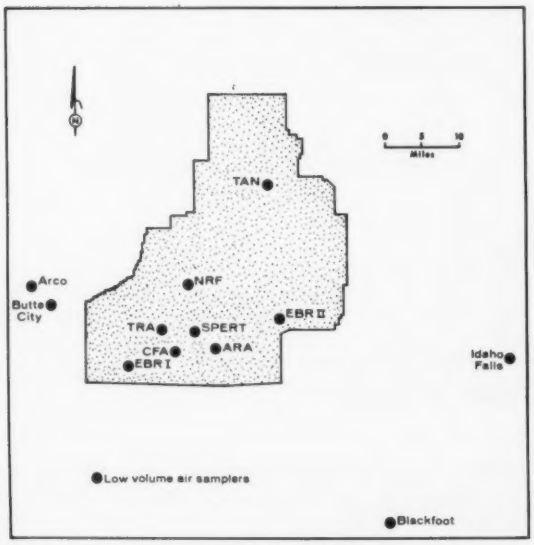


**Figure 2. Onsite and offsite air sampling locations National Reactor Testing Station**

The filters were analyzed 5 days after the end of each sampling period to allow for decay of short-lived natural radioactivity. Gross alpha and beta analyses were performed on the membrane filters and gross beta analyses alone were performed on the charcoal filters. Activity detected on the charcoal filters was assumed to be iodine-131. Gross alpha activity was determined by a technique reported by Hallden and Harley (*1*). Using this method, an alpha-sensitive phosphor disc was placed in direct contact with the filter and counted with a low-noise photomultiplier tube. For gross beta analyses, the filters were mounted on a ringed planchet and counted in a low background beta counter. At the end of each calendar quarter, the particulate filters from selected locations were composited and the concentrations of gamma-emitting radionuclides determined by gamma spectrometry. A strontium-90 analysis also was performed on the quarterly composites. Each membrane filter was dried and weighed before and after use to determine the average airborne particulate concentrations during the sampling period.

Onsite air samples were collected at locations close to the sources of released radioactivity and were expected to have the highest concentrations. Background samples were collected at Idaho Falls, Blackfoot, and Pocatello. These locations were sufficiently remote to ensure that any radioactivity detected was due to natural background or sources other than NRTS operations. Levels of radioactivity in onsite and boundary community (Arco and Butte City) air samples were compared to levels in the background samples. If the radioactivity levels were found to be significantly higher than background, the net amount above background was assumed to be radioactivity introduced to the environment from NRTS operations. The net concentrations of radioactivity then were compared to the AEC standards set forth in the U.S. Atomic Energy Commission's Manual Chapter 0524 (AECM 0524). The air sampling data are presented in table 1.

The gross alpha air concentrations at the background locations of Idaho Falls, Blackfoot, and Pocatello were not representative of the NRTS background levels. This was due to higher airborne concentrations of naturally occurring radioactivity in the upper Snake River Valley. Therefore, the onsite gross alpha concentrations and the gross alpha concentra-

**Table 1. Radioactivity in air, National Reactor Testing Station, January-December 1970**

| Sampling locations | Number of samples collected | Type of analysis and filter | Minimum detectable concentration (fCi/m³) | Maximum single sample concentration (fCi/m³) | Average sample concentration (fCi/m³) | Average background concentration, if applicable (fCi/m³) | Maximum average net concentration (fCi/m³) | AEC standard (fCi/m³) | Maximum average net concentration percent of standard |
|---|---|---|---|---|---|---|---|---|---|
| Onsite (8 locations) | 416 | Gross alpha; membrane | 1 | 5.6 | 1.8 | | 1.8 | 6,000 | 0.03 |
| | | Gross beta; membrane | 10 | 4,400 | 600 | 430 | 170 | [a] 30,000 | .57 |
| | | Gross beta; charcoal | 10 | 40 | <10 | <10 | <10 | $9\times10^{6}$ | <.001 |
| EBR-I (onsite) | 52 | $^{144}$Ce-Pr; membrane | | | 100 | 60 | 40 | $6\times10^{6}$ | <.001 |
| | | $^{125}$Sb; membrane | | | 8.0 | | 8.0 | $3\times10^{7}$ | <.001 |
| | | $^{134}$Cs; membrane | | | 5.7 | .6 | 5.1 | $4\times10^{7}$ | <.001 |
| | | $^{137}$Cs; membrane | | | 29 | 7.5 | 21 | $1\times10^{7}$ | <.001 |
| | | $^{106}$Ru-Rh; membrane | | | 38 | 28 | 10 | $6\times10^{6}$ | <.001 |
| | | $^{95}$Zr; membrane | | | 3.4 | 1.7 | 1.7 | $3\times10^{7}$ | <.001 |
| | | $^{95}$Nb; membrane | | | 6.9 | 4.0 | 2.9 | $1\times10^{8}$ | <.001 |
| | | $^{54}$Mn; membrane | | | .2 | .5 | | $4\times10^{7}$ | |
| | | $^{60}$Co; membrane | | | 2.9 | | 2.9 | $9\times10^{6}$ | <.001 |
| | | $^{90}$Sr; membrane | | | 18 | 4 | 14 | $1\times10^{9}$ | <.001 |
| | | $^{103}$Ru; membrane | | | 3.4 | | 3.4 | $8\times10^{7}$ | <.001 |
| Arco (offsite) | 52 | Gross alpha; membrane | 1 | 6.2 | 2.0 | | 2.0 | 20 | 10 |
| | | Gross beta; membrane | 10 | 1,000 | 420 | 430 | | [a] 1,000 | |
| | | Gross beta; charcoal | 10 | 10 | <10 | <10 | <10 | $1\times10^{5}$ | <.01 |
| Butte City (offsite) | 52 | Gross alpha; membrane | 1 | 5.2 | 1.8 | | 1.8 | 20 | 9 |
| | | Gross beta; membrane | 10 | 1,600 | 500 | 430 | 70 | [a] 1,000 | 7 |
| | | Gross beta; charcoal | 10 | 30 | <10 | <10 | <10 | $1\times10^{5}$ | <.01 |
| | | $^{144}$Ce-Pr; membrane | | | 79 | 60 | 19 | $2\times10^{5}$ | .01 |
| | | $^{125}$Sb; membrane | | | 5.0 | | 5.0 | $9\times10^{5}$ | <.001 |
| | | $^{103}$Ru; membrane | | | .2 | | .2 | $3\times10^{6}$ | <.001 |
| | | $^{106}$Ru-Rh; membrane | | | 24 | 28 | | $2\times10^{5}$ | |
| | | $^{134}$Cs; membrane | | | 2.1 | .6 | 1.5 | $4\times10^{5}$ | <.001 |
| | | $^{137}$Cs; membrane | | | 9.3 | 7.5 | 1.8 | $5\times10^{5}$ | <.001 |
| | | $^{95}$Zr; membrane | | | 3.9 | 1.7 | 2.2 | $1\times10^{6}$ | <.001 |
| | | $^{95}$Nb; membrane | | | 6.0 | 4.0 | 2.0 | $3\times10^{6}$ | <.001 |
| | | $^{54}$Mn; membrane | | | .8 | .5 | .3 | $1\times10^{6}$ | <.001 |
| | | $^{90}$Sr; membrane | | | 5.2 | 3.9 | 1.3 | 30,000 | .004 |

[a] Assumes actinium-227 not present.

tions at the NRTS boundary communities were not compared to an average background concentration. However, if measurable onsite releases of alpha activity were occurring, it would have been expected that the gross alpha concentrations at onsite locations would be higher than at the communities near the NRTS boundary. This pattern was not observed and indicates the gross alpha concentrations measured at the NRTS and boundary community locations were the result of natural background radioactivity.

Excluding the results from the last 2 weeks of 1970, all the gross beta (iodine-131) concentrations determined from the charcoal filters were near or below the detection limit of the analysis. For 1970, the average gross beta concentration of particulates at onsite locations was 0.6 pCi/m³ and the highest individual average was 0.8 pCi/m³, occurring at the CFA location. The yearly average background gross beta concentration was 0.44 pCi/m³. The difference between the average onsite and offsite gross beta concentration was largely the result of releases of small quantities of radioactivity from the Idaho Chemical Processing Plant. Fission and activation products identified on the onsite particulate filters were cerium-praseodymium-144, antimony-125, cesium-134, cesium-137, ruthenium-rhodium-106, ruthenium-103, zirconium-95, niobium-95, manganese-54, cobalt-60, and strontium-90. All but antimony-125, ruthenium-103, and cobalt-60, also were identified on the background air filters, though generally in smaller concentrations. None of the concentrations of radionuclides identified on the onsite filters exceeded 0.001 percent of the corresponding AEC standards.

At the air sampling locations of Butte City and Arco, the offsite sampling locations closest to the NRTS, it was found that the average gross beta concentration (at Butte City) was slightly above the worldwide fallout level. The yearly average net gross beta concentration of 0.07 pCi/m³ was only 1 percent of the appropriate concentration guide. Except for cobalt-60 the same radionuclides identified in the onsite samples also were found at Butte City, although generally in smaller concentrations. None of the net concentrations of radionuclides identified on the Butte City filters exceeded 0.01 percent of the concentration guide.

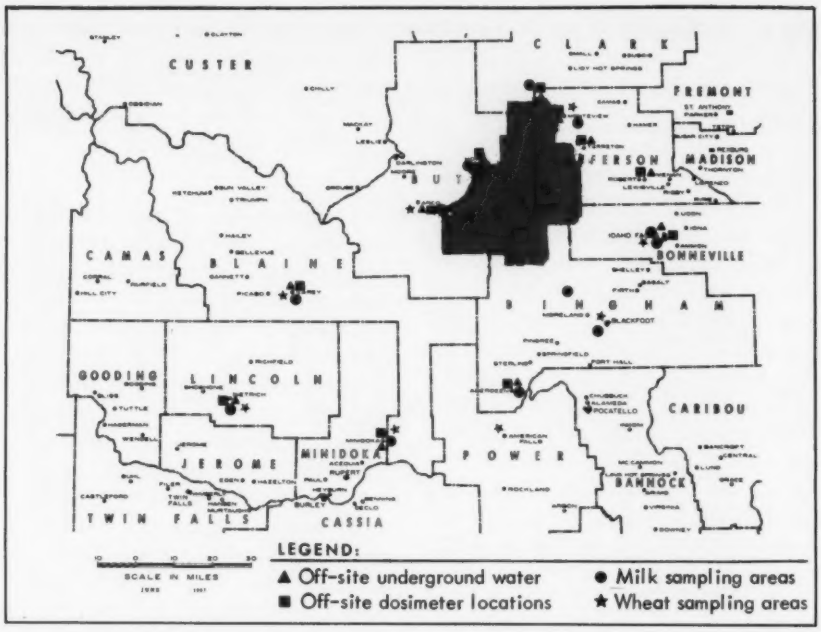


**Figure 3. Environmental monitoring program, National Reactor Testing Station**

*Water monitoring*

Water samples were collected from onsite and offsite drinking water production wells and from the Snake River. Offsite and onsite water sampling locations can be seen in figures 3 and 4, respectively. All offsite samples were collected biannually; generally onsite samples were collected every 2 weeks. Gross alpha, gross beta, and tritium analyses routinely were performed on the water samples. For gross alpha analysis, an aliquot of the sample was evaporated on a stainless-steel planchet and counted with a scintillation counter using a technique similar to that described for the gross alpha analysis for the air filters. Another aliquot was evaporated and counted for gross beta activity in a low background beta counter. Tritium concentrations were determined with a Beckman liquid scintillation system. Water sampling data are presented in tables 2 and 3. Samples collected from Mud Lake, Monteview, Reno Ranch, Idaho Falls, and Roberts (all upgradient in the aquifer from the NRTS) were used to determine the background concentrations of radioactivity.

None of the offsite water samples collected during 1970 contained concentrations of radioactivity above the detection limits of the analyses. Only a few onsite samples contained gross alpha concentrations above the detection limit of 3 pCi/liter. The highest average beta concentration, 49 pCi/liter, was found in well number 1 at the Idaho Chemical Processing Plant. This well was used only during the first half of 1970. During the second half of the year, ICPP well number 2 had an average gross beta concentration of 16 pCi/liter. The 1970 average strontium-90 concentrations were 16 pCi/liter and 3.1 pCi/liter for ICPP wells number 1 and number 2, respectively. These strontium-90 concentrations are less than 2 percent of the AECM 0524 standard. The highest 1970 average tritium concentration, 100 nCi/liter was found in well number 1 at the Central Facilities Area (CFA) and was 3 percent of the AECM 0524 standard.

*Food monitoring*

Milk was the main foodstuff sampled. A composite grade A sample was collected from farm areas to the north and south of Idaho Falls

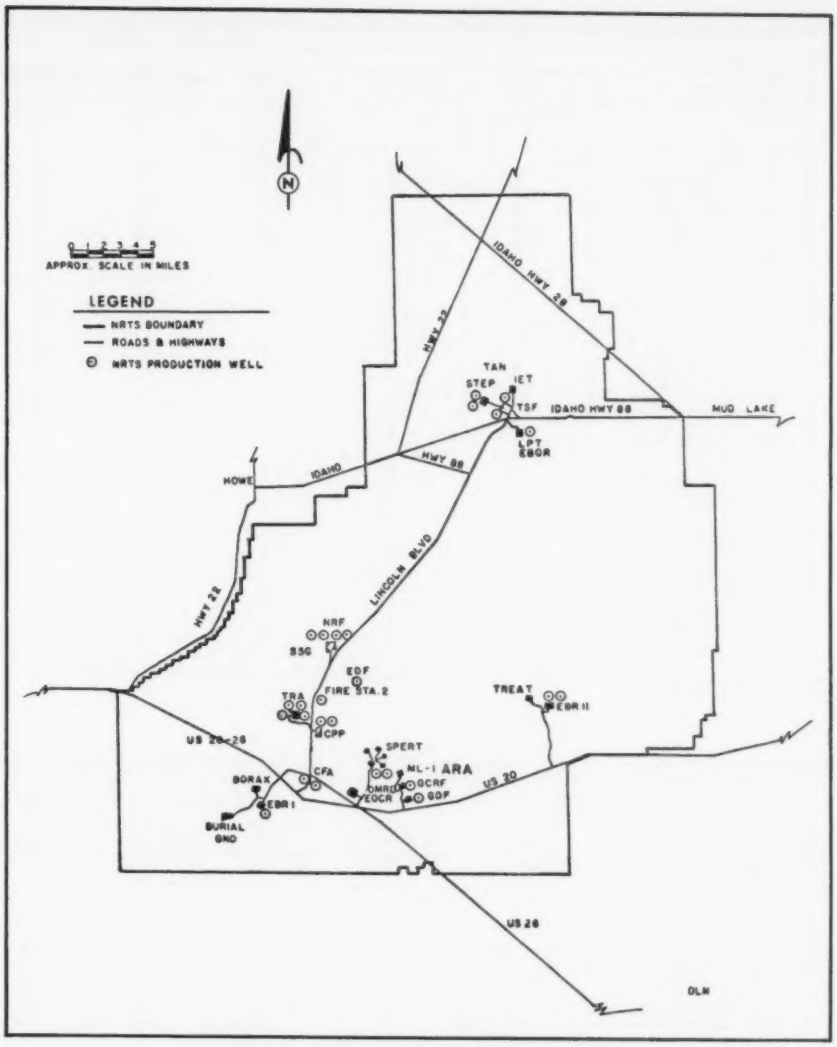


**Figure 4. National Reactor Testing Station**

each week. Monthly grade B milk samples were collected from dairies and individual farms in rural areas surrounding the NRTS. Analysis by gamma spectrometry for iodine-131 and cesium-137 was performed on all milk samples. Biannually the samples were analyzed for strontium-90. Wheat samples were collected from individual farms and grain elevators during the fall harvest and analyzed for gamma-emitting radionuclides by gamma spectrometry and for strontium-90. See figure 3 for the milk and wheat sampling locations.

All milk sampling results summarized in table 4 were compared to standards recommended by the Federal Radiation Council, since the AECM 0524 does not list concentration guides for milk. Neither iodine-131 nor cesium-137 was detected in any milk sample collected during 1970. Strontium-90 concentrations in milk were less than 2 percent of the standard.

**Table 2. Radioactivity in well water samples, National Reactor Testing Station, January-December 1970**

| Sampling locations | Number of samples collected | Type of analysis | Maximum single sample concentration (pCi/liter) | Minimum detectable concentration (pCi/liter) | Average sample concentration (pCi/liter) | Average background concentration (pCi/liter) | Maximum average net concentration (pCi/liter) | Maximum average net concentration percent of standard |
|---|---|---|---|---|---|---|---|---|
| EBR-I (1 well) | 24 | Gross alpha | 3.3 | 3 | <3.0 | <3 | <3 | <10 |
| | | Gross beta | 7.3 | 5 | <5.0 | <5 | <5.0 | <17 |
| | | Tritium | [b] <2 | [b] 2 | [b] <2 | [b] <2 | [b] <2 | <0.7 |
| CFA (2 wells) | 24 | Gross alpha | <3 | 3 | <3 | <3 | <30 | <10 |
| | | Gross beta | 9.1 | 5 | <5.2 | <5 | <5.2 | <17 |
| | | Tritium | [b] 180 | [b] 2 | [b] 78 | [b] <2 | [b] 78 | 2.6 |
| TRA (3 wells) | 29 | Gross alpha | 8.0 | 3 | <3.0 | <3 | <3.0 | <10 |
| | | Gross beta | <5 | 5 | <5 | <5 | <5 | <17 |
| | | Tritium | [b] <2 | [b] 2 | [b] <2 | [b] <2 | [b] <2 | <.07 |
| CPP (2 wells) | 68 | Gross alpha | 5.6 | 3 | <3.1 | <3 | <3.1 | <10 |
| | | Gross beta | 65 | 5 | 24 | <5 | 24 | 80 |
| | | Tritium | [b] 280 | [b] 2 | [b] 48 | [b] <2 | [b] 48 | 1.6 |
| | | Strontium-90 | 10 | 1 | 3.1 | | 3.1 | 1.0 |
| NRF (3 wells) | 64 | Gross alpha | <3 | 3 | <3 | <3 | <3 | <10 |
| | | Gross beta | 9.5 | 5 | <5.2 | <5 | <5.2 | <17 |
| | | Tritium | [b] <2 | [b] 2 | [b] <2 | [b] <2 | [b] <2 | <.07 |
| TAN (5 wells) | 120 | Gross alpha | 23 | 3 | <3.2 | <3 | <3.2 | <11 |
| | | Gross beta | 20 | 5 | <5.3 | <5 | <5.3 | <18 |
| | | Tritium | [b] <2 | [b] 2 | [b] <2 | <2 | [b] <2 | <.07 |
| SPERT-PBF (2 wells) | 36 | Gross alpha | 6.5 | 3 | <3.1 | <3 | <3.1 | <10 |
| | | Gross beta | <5 | 5 | <5 | <5 | <5 | <17 |
| | | Tritium | [b] <2 | [b] 2 | [b] <2 | [b] <2 | [b] <2 | <.07 |
| ARA (2 wells) | 48 | Gross alpha | 5 | 3 | <3.0 | <3 | <3.0 | <10 |
| | | Gross beta | <5 | 5 | <5 | <5 | <5 | <17 |
| | | Tritium | [b] <2 | [b] 2 | [b] <2 | [b] <2 | [b] <2 | <.07 |
| EDF (1 well) | 12 | Gross alpha | <3 | 3 | <3 | <3 | <3 | <10 |
| | | Gross beta | 5.9 | 5 | <5.0 | <5 | <5.0 | <17 |
| | | Tritium | [b] <2 | [b] 2 | [b] <2 | [b] <2 | [b] <2 | <.07 |
| EBR-II (2 wells) | 30 | Gross alpha | 6.5 | 3 | <3.2 | <3 | <3.2 | <11 |
| | | Gross beta | 5 | 5 | <5 | <5 | <5 | <17 |
| | | Tritium | [b] <2 | [b] 2 | [b] <2 | [b] <2 | [b] <2 | <.07 |
| Fire station #2 (1 well) | 24 | Gross alpha | 5.5 | 3 | <3.1 | <3 | <3.1 | <10 |
| | | Gross beta | 6.8 | 5 | <5.0 | <5 | <5.0 | <17 |
| | | Tritium | [b] <2 | [b] 2 | [b] <2 | [b] <2 | [b] <2 | <.07 |

[a] AEC standards—gross alpha, 30 pCi/liter; gross beta, 30 pCi/liter; tritium, 3,000 pCi/liter, and strontium-90, 300 pCi/liter.
[b] Concentration of tritium in nCi/liter.

**Table 3. Radioactivity in offsite drinking water and surface water samples, National Reactor Testing Station January-December 1970**

| Sampling locations | Number of samples collected | Type of analysis | Maximum single sample concentration (pCi/liter) | Minimum detectable concentration (pCi/liter) | Average sample concentration (pCi/liter) | Average background concentration if applicable (pCi/liter) | Maximum average net concentration (pCi/liter) | Maximum average net concentration percent of standard[a] |
|---|---|---|---|---|---|---|---|---|
| Drinking water, from Arco, Carey, Aberdeen, Dietrich, Atomic City, and Minidoka | 12 | Gross alpha | <3 | 3 | <3 | <3 | <3 | <10 |
| | | Gross beta | 5 | 5 | <5 | <5 | <5 | <17 |
| | | Tritium | [b] <2 | [b] 2 | [b] <2 | [b] <2 | [b] <2 | <.07 |
| Snake River at Bliss, Idaho | 2 | Gross alpha | <3 | 3 | <3 | <3 | <3 | <10 |
| | | Gross beta | <5 | 5 | <5 | <5 | <5 | <17 |
| | | Tritium | [b] <2 | [b] 2 | [b] <2 | [b] <2 | [b] <2 | <.07 |

[a] AEC standard—gross alpha, 30 pCi/liter; gross beta, 30 pCi/liter; tritium, 3,000 nCi/liter.
[b] Concentration of tritium in nCi/liter.

The strontium-90 concentrations were similar to those reported in *Radiological Health Data and Reports* for this region of the country and the source is believed to be fallout from nuclear weapons and not NRTS operations. Only strontium-90 activity was detected in the wheat samples with the hull containing 90 percent of the total. This means only 10 percent of the activity will remain after the wheat is processed for use in food products. The strontium-90 in wheat also is attributed to worldwide fallout. Wheat sampling results are shown in table 5.

**Table 4. Radionuclide concentrations in milk, National Reactor Testing Station, January-December 1970**

| Location and sampling frequency | Analysis | Maximum single sample concentration (pCi/liter) | Average sample concentration (pCi/liter) | Average concentration percent of standard[a] |
|---|---|---|---|---|
| Idaho Falls (weekly) | Iodine-131 | <20 | <20 | <20 |
| | Cesium-137 | <30 | <30 | <.8 |
| | Strontium-90[b] | 9.4 | 6.2 | 3.1 |
| Minidoka (monthly) | Iodine-131 | <20 | <20 | <20 |
| | Cesium-137 | <30 | <30 | <.8 |
| | Strontium-90[b] | 4 | 2.8 | 1.4 |
| Dietrich (monthly) | Iodine-131 | <20 | <20 | <20 |
| | Cesium-137 | <30 | <30 | <.8 |
| | Strontium-90[b] | 4 | 3.4 | 1.7 |
| Carey (monthly) | Iodine-131 | <20 | <20 | <20 |
| | Cesium-137 | <30 | <30 | <.8 |
| | Strontium-90[b] | 3 | 2.8 | 1.4 |
| Mud Lake (monthly) | Iodine-131 | <20 | <20 | <20 |
| | Cesium-137 | <30 | <30 | <.8 |
| | Strontium-90[b] | 3.6 | 3.3 | 1.7 |
| Reno Ranch (monthly) | Iodine-131 | <20 | <20 | <20 |
| | Cesium-137 | <30 | <30 | <.8 |
| | Strontium-90[c] | 1.2 | 1.2 | .6 |
| Tabor (monthly) | Iodine-131 | <20 | <20 | <20 |
| | Cesium-137 | <30 | <30 | <.8 |
| | Strontium-90[b] | 3 | 2.5 | 1.3 |
| Howe (monthly) | Iodine-131 | <20 | <20 | <20 |
| | Cesium-137 | <30 | <30 | <.8 |
| | Strontium-90[b] | 4.5 | 4.2 | 2.1 |
| Arco (monthly) | Iodine-131 | <20 | <20 | <20 |
| | Cesium-137 | <30 | <30 | <.8 |
| | Strontium-90[b] | 3.5 | 2.2 | 1.1 |
| Firth and New Sweden (near Idaho Falls) (monthly) | Iodine-131 | <20 | <20 | <20 |
| | Cesium-137 | <30 | <30 | <.8 |
| | Strontium-90[b] | 3.4 | 3.2 | 1.6 |
| Lake and Riverside (Tabor-Blackfoot-Aberdeen area, monthly) | Iodine-131 | <20 | <20 | <20 |
| | Cesium-137 | <30 | <30 | <.8 |
| | Strontium-90[b] | 3 | 2.3 | 1.2 |

[a] Federal Radiation Council standard: iodine-131, 100 pCi/liter; cesium-137, 3,600 pCi/liter; strontium-90, 200 pCi/liter.
[b] Only two samples during the year were analyzed for strontium-90 activity.
[c] Only one sample during the year was analyzed for strontium-90 activity.

**Table 5. Strontium-90 concentrations in wheat National Reactor Testing Station, January-December 1970**

| Sampling location | Strontium-90 concentration (pCi/g) |
|---|---|
| Monteview | 0.021 |
| Idaho Falls | .014 |
| Blackfoot | .01 |
| American Falls | .014 |
| Minidoka | .016 |
| Dietrich | .009 |
| Carey | .013 |
| Arco | .0046 |

**Table 6. Gamma radiation monitoring data, National Reactor Testing Station, January-December 1970**

| Location | Exposure (mR) | |
|---|---|---|
| | May-November 1970 | November 1969-November 1970 |
| Background locations: | | |
| Idaho Falls AEC headquarters | 48.5 | [a] 48.5—64.6 |
| Idaho Falls Airport | 37.9 | 57.7 |
| Blackfoot | 51.2 | [a] 51.2—65.1 |
| Carey | <13 | <29 |
| Dietrich | 26.2 | [b] |
| Aberdeen | 34.9 | [a] 34.9—55.9 |
| Minidoka | 20.0 | 30.7 |
| NRTS perimeter locations: | | |
| Arco | 34.9 | 49.8 |
| Butte City | 39.9 | [a] 39.9—61.7 |
| Mud Lake | 26.4 | 42.8 |
| Howe | 34.2 | 47.8 |
| Atomic City | 38.4 | 60.6 |
| Roberts | 43.3 | 60.8 |

[a] A range is reported when the exposure from November 1969 to May 1970 was below the detection limit. The lower value assumes the exposure was zero during this period; the high value assumes the exposure was equal to the detection limit and is the maximum possible yearly exposure.
[b] No data available for the November 1969 to May 1970 exposure period.

### *Gamma radiation exposure*

Environmental gamma radiation exposures were measured with thermoluminescent dosimeters (TLDs) placed at both onsite and offsite locations. The exposures reported in table 6 were the amounts greater than those received by a control group of dosimeters placed in a lead shield in the laboratory. Thus, the reported exposures do not include all the exposure which results from natural background. Exposures at the distant locations of Idaho Falls, Blackfoot, Dietrich, Carey, Aberdeen, and Minidoka were considered background levels. Because of the unusually low exposure at Carey, the results at that location are questionable. The maximum

exposure at the boundary communities of Atomic City, Howe, Arco, Butte City, Mud Lake, and Roberts was 62 mR at Butte City for the period, November 1969 to November 1970. The highest exposure at a background location during the same period was 65 mR at Blackfoot. There was no evidence that any of the offsite exposures were the result of NRTS activities.

*Summary*

The results of the air monitoring program for 1970 indicated that any increases in offsite air concentrations due to NRTS releases were indistiguishable from the natural radioactivity in air. When special techniques were used to measure the worldwide radioactive fallout (approximately 0.2 percent to 2 percent of the natural radioactivity in air), the sensitivity was high enough to indicate small releases of NRTS activity measurable above the worldwide fallout. The average increased exposure by airborne radioactivity just offsite was approximately 0.5 percent of the natural radon series and thoron series exposure in air. From identification of specific radionuclide concentrations it was found that none of the concentrations was greater than 0.01 percent of the appropriate standard listed in AECM 0524.

None of the offsite well water or surface water samples contained any gross alpha, gross beta, or tritium activity above the detection limits of the analyses. The only fission or activation product detected in milk samples was strontium-90. These concentrations were similar to those reported in *Radiological Health Data and Reports* for the region and the source is believed to be fallout from nuclear weapons and not NRTS operations. Wheat samples collected at harvest also contained small amounts of strontium-90 from worldwide fallout.

Gamma radiation exposures were measured simultaneously at distant background locations and at communities near the NRTS boundary. There was no evidence that the exposures at the NRTS boundary communities were different from background.

REFERENCE

(*1*) HALLDEN and HARLEY. An improved alpha counting technique. Anal Chem 32:1861 (1960).

## 2. Oak Ridge Area[3] July–December 1970

*Union Carbide Nuclear Company*
*Oak Ridge, Tenn.*

Oak Ridge area is a complex made up primarily of the Y–12 Plant, the Oak Ridge National Laboratory (ORNL), and the Oak Ridge Gaseous Diffusion Plant (ORGDP).

Radioactive waste materials arising from the operation of atomic energy installations in the Oak Ridge area are collected, treated, and disposed of according to their physical states. Solid wastes are buried in a Conasauga shale formation which has a marked ability to fix radioactive materials by an ion exchange mechanism. Liquid wastes which contain long-lived fission products are confined in storage tanks or are concentrated by evaporation and disposed of in deep wells. Low-level liquid wastes are discharged, after preliminary treatment, to the surface streams. Air that may become contaminated by radioactive materials is exhausted to the atmosphere from several tall stacks after treatment by means of scrubbers and filters.

*Air monitoring*

Atmospheric contamination by radioactive

[3] Summarized from Environmental Levels of Radioactivity for the Oak Ridge area, (Report Period, July–December 1970). Health Physics and Safety Section, Health Physics Division, Oak Ridge National Laboratory.

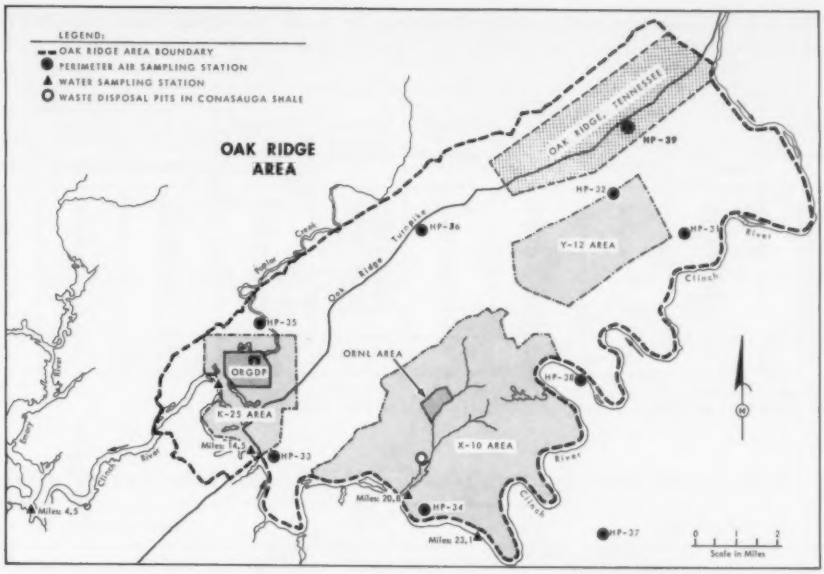


**Figure 5. Oak Ridge Area environmental sampling locations**

materials occurring in the general environment of East Tennessee is monitored by two systems of monitoring stations. One system consists of nine stations which encircle the plant areas (figure 5) and provide data for evaluating the impact of all Oak Ridge operations on the immediate environment. A second system consists of eight stations encircling the Oak Ridge area at distances of from 12 to 75 miles (figure 6). This system provides data to aid in evaluating local conditions and to assist in determining the spread or dispersal of contamination should a major incident occur.

Sampling for radioactive particulates is carried out by passing air continuously through a filter paper. Average radioactivity concentrations are presented in tables 7 and 8. Airborne radioactive iodine is sampled in the immediate environment of the plant areas by passing air through a cartridge containing activated charcoal.

During the July-December 1970 surveillance period, 234 samples were collected from perimeter monitoring stations and analyzed for iodine-131. Of these, the maximum concentration detected was 0.037 pCi/m$^3$, the minimum was less than 0.01 pCi/m$^3$ and the average was 0.01 pCi/m$^3$. The radiation protection standard specified in the AEC manual for iodine-131 in the ambient atmosphere in uncontrolled areas is 100 pCi/m$^3$.

### *Milk monitoring*

Raw milk is monitored for iodine-131 and strontium-90 by the collection and analysis of samples from 12 sampling stations located within a radius of 50 miles of ORNL. Samples are collected weekly at each of eight stations located on the fringe of the Oak Ridge area. Four stations, located more remotely with respect to the Oak Ridge operations, are sampled at a rate of one station each week. The purpose of the milk sampling program is twofold: first, samples collected in the immediate vicinity of the Oak Ridge area provide data by which one may evaluate possible exposure to the neighboring population resulting from waste releases from Oak Ridge operations; second, samples collected at the more remote stations provide background data which are essential in establishing the proper index for the evaluation of data obtained from local samples. The concentrations of iodine-131 and strontium-90 detected in raw milk samples during the period are given in table 9.

**Table 7. Long-lived gross beta radioactivity of particulates in air, Oak Ridge Area, July-December 1970**

| Perimeter stations | | | | | | Remote stations | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Station number (figure 5) | Number of samples | Concentration (fCi/m³) | | | Percent of AEC standard[a] | Station number (figure 6) | Number of samples | Concentration (fCi/m³) | | | Percent of AEC standard[a] |
| | | Maximum | Minimum | Average | | | | Maximum | Minimum | Average | |
| HP-31 | 26 | 440 | 29 | 150 | 0.15 | HP-51 | 26 | 490 | 54 | 170 | 0.17 |
| HP-32 | 26 | 540 | 34 | 190 | .19 | HP-52 | 26 | 620 | 42 | 200 | .20 |
| HP-33 | 26 | 380 | 57 | 150 | .15 | HP-53 | 26 | 560 | 43 | 210 | .21 |
| HP-34 | 26 | 490 | 24 | 170 | .17 | HP-54 | 26 | 560 | 6 | 190 | .19 |
| HP-35 | 26 | 500 | 21 | 180 | .18 | HP-55 | 26 | 610 | 46 | 220 | .22 |
| HP-36 | [b] 123 | 540 | 87 | 220 | .22 | HP-56 | 26 | 490 | 45 | 170 | .17 |
| HP-37 | 26 | 430 | 55 | 150 | .15 | HP-57 | 26 | 420 | 58 | 150 | .15 |
| HP-38 | 26 | 480 | 59 | 190 | .19 | HP-58 | 24 | 570 | 18 | 210 | .21 |
| HP-39 | 26 | 580 | 23 | 180 | .18 | | | | | | |
| Summary | 331 | 580 | 21 | 170 | 0.17 | Summary | 206 | 620 | 6 | 190 | 0.19 |

[a] The applicable AEC radiation protection standard is 100 pCi/m³.
[b] Sample frequency—5 days per week.

**Table 8. Long-lived gross alpha radioactivity of particulates in air, Oak Ridge Area, July-December 1970**

| Perimeter stations | | | | | | Remote stations | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Station number (figure 5) | Number of samples | Concentration (pCi/m³) | | | Percent of AEC standard[a] | Station number (figure 6) | Number of samples | Concentration (pCi/m³) | | | Percent of AEC standard[a] |
| | | Maximum | Minimum | Average | | | | Maximum | Minimum | Average | |
| HP-31 | 26 | 3 | <1 | 1 | 0.05 | HP-51 | 26 | 3 | <1 | 1 | 0.05 |
| HP-32 | 26 | 5 | <1 | 2 | .10 | HP-52 | 26 | 5 | <1 | 2 | .10 |
| HP-33 | 26 | 3 | <1 | 1 | .05 | HP-53 | 26 | 5 | <1 | 1 | .05 |
| HP-34 | 26 | 4 | <1 | 1 | .05 | HP-54 | 26 | 8 | <1 | 1 | .05 |
| HP-35 | 26 | 8 | <1 | 1 | .05 | HP-55 | 26 | 4 | <1 | 1 | .05 |
| HP-36 | 123 | 10 | <1 | 5 | .25 | HP-56 | 26 | 5 | <1 | 1 | .05 |
| HP-37 | 26 | 2 | <1 | <1 | <.05 | HP-57 | 26 | 3 | <1 | 1 | .05 |
| HP-38 | 26 | 5 | <1 | 1 | .05 | HP-58 | 24 | 6 | <1 | 2 | .10 |
| HP-39 | 26 | 6 | <1 | 1 | .05 | | | | | | |
| Summary | 331 | 10 | <1 | 2 | 0.10 | Summary | 206 | 8 | <1 | 1 | 0.05 |

[a] The applicable AEC radiation protection standard for natural uranium in air is 2 pCi/m³.
[b] Sampling frequency—5 days per week.

**Table 9. Radionuclides in raw milk, Oak Ridge area July-December 1970**

| Radionuclide and location | Concentration (pCi/liter) | | |
|---|---|---|---|
| | Maximum | Minimum[a] | Average |
| Iodine-131 | | | |
| Immediate environs | 22 | <10 | <10 |
| Remote environs | 11 | <10 | <10 |
| Strontium-90 | | | |
| Immediate environs | 25 | 2.0 | 11.6 |
| Remote environs | 13 | 2.0 | 8.4 |

[a] The minimum detectable concentrations of iodine-131 and strontium-90 in milk are 10 pCi/liter and 2 pCi/liter, respectively. In averaging, one-half of the minimum detectable concentration was used for all samples showing an activity less than this concentration.

### *Water monitoring*

Large volume, low-level liquid wastes originating at ORNL are discharged, after some preliminary treatment, into the Tennessee River system by way of White Oak Creek and the Clinch River. Liquid wastes originating at the ORGDP and Y–12 Plant are discharged to Poplar Creek and thence to the Clinch River. Releases are controlled so that resulting average concentrations in the Clinch River comply with AEC radiation protection standards. The radioactivity concentration from White Oak Creek is measured, and concentration values for the Clinch River are calculated on the basis of the dilution provided by the river.

Water samples are taken at a number of locations in the Clinch River, beginning at a point above the entry of wastes into the river and ending at Center's Ferry near Kingston, Tenn. Stream gauging operations are carried on continuously to obtain dilution factors for calculating the probable concentrations of

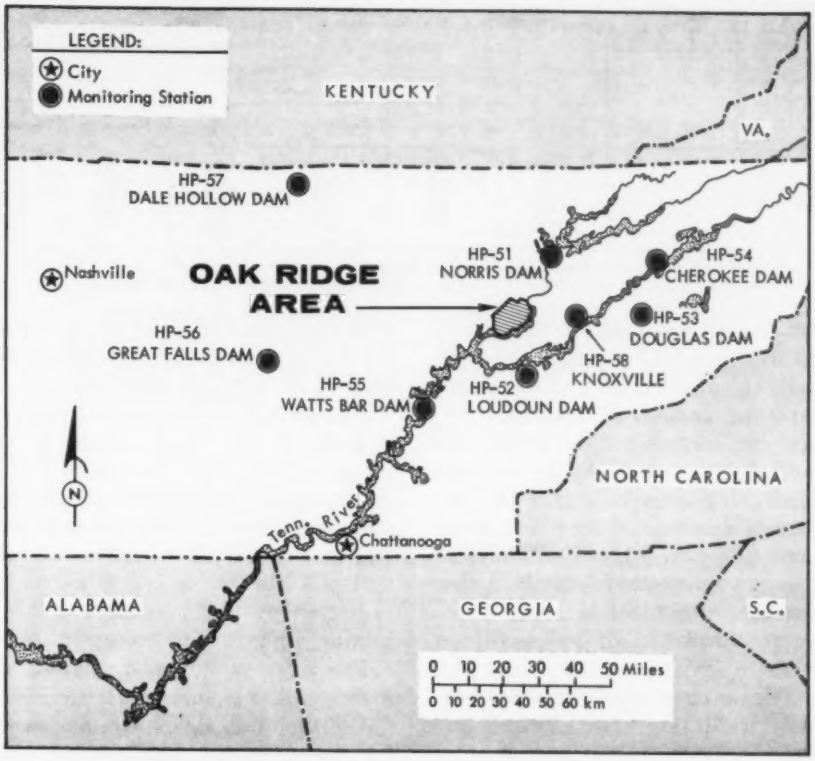


**Figure 6. Remote air monitoring stations, Oak Ridge area**

wastes in the river. Samples are analyzed for the long-lived beta-particle emitters, uranium, and the transuranic alpha-particle emitters. The average concentrations of major radionuclides in the Clinch River are given in table 10 for the period from July–December 1970.

**Table 10. Concentrations of major radionuclides in the Clinch River, July-December 1970**

| Radionuclide | Average concentration (pCi/liter) | | | |
|---|---|---|---|---|
| | Location on Clinch River[a] | | | |
| | Mile 23.1 (Upstream) | Mile 20.8[b] (Outfall) | Mile 14.5 (Downstream) | Mile 4.5 (Downstream) |
| Strontium-90 | 0.4 | 0.5 | 1.4 | 0.8 |
| Cerium-144 | .2 | <.1 | .3 | .3 |
| Cesium-137 | .2 | .1 | 1.4 | .9 |
| Ruthenium-103-106 | .4 | .2 | .5 | .6 |
| Cobalt-60 | .2 | <.1 | .7 | .3 |
| Zirconium-niobium-95 | .1 | <.1 | <.1 | <.1 |
| Tritium | 560 | 980 | 1,080 | 1,330 |

[a] The location on Clinch River is given in terms of the distance upstream from the Tennessee River (figure 5).
[b] The concentrations at mile 20.8 are not measured directly but the values are calculated based on the levels of waste released from White Oak dam and the dilution provided by the Clinch River.

Two quarterly composite water samples from the Clinch River were analyzed for uranium during this period. For these samples, the uranium concentrations were less than 1 pCi/liter, the level of detectability. The AEC radiation protection standard for natural uranium in water released to unrestricted areas is 20 nCi/liter.

### *Gamma measurements*

External gamma radiation levels are measured monthly at a number of locations in the Oak Ridge area. Measurements are taken with a Geiger-Mueller tube at a distance of 3 feet above the ground. The results are shown in table 11.

### *Discussion of data*

The average air contamination levels for gross beta radioactivity, as shown by the continuous air monitoring filter data, for both the

Table 11. External gamma radiation levels, Oak Ridge area, July-December 1970

| Station | Exposure (mR/h) | | | | | | |
|---|---|---|---|---|---|---|---|
| | July | August | September | October | November | December | Average |
| Kerr Hollow Gate | 0.010 | 0.016 | 0.010 | 0.014 | 0.012 | [b] | 0.012 |
| Y-12, East Portal | .008 | .012 | .012 | .013 | .011 | [b] | .011 |
| Newcomb Road | .011 | .012 | .011 | .012 | .009 | [b] | .011 |
| Gallaher Gate | .009 | .010 | .010 | .014 | .012 | [b] | .011 |
| White Wing Gate | .012 | .010 | .011 | .012 | .010 | [b] | .011 |

[a] These readings were taken with a calibrated Geiger-Müller tube at a distance of 3 feet above the ground.
[b] Background not taken.

immediate and remote environs of the plants (figures 5 and 6) were 0.17 percent and 0.19 percent, respectively, of the AEC radiation protection standard for uncontrolled areas.

The average air contamination levels for gross alpha radioactivity, as shown by the continuous air monitoring filter data, for the immediate and remote environs of the plants were 0.10 percent and 0.05 percent, respectively, of the AEC radiation protection standard for natural uranium for uncontrolled areas.

The average concentration of iodine-131 in air in the immediate environs of the plants was 0.01 pCi/m$^3$. This is approximately 0.01 percent of the AEC radiation standard for uncontrolled areas.

The average concentrations of iodine-131 in raw milk in the immediate and remote environs of the Oak Ridge area were both less than 10 pCi/liter. These levels fall within the limits of FRC Range I if the average intake per individual is assumed to be 1 liter of milk per day.

The average concentrations of strontium-90 in raw milk in both the immediate and remote environs of the controlled areas was 11.6 pCi/liter and 8.4 pCi/liter, respectively. The average falls within the limits of FRC Range I for transient rates of daily intake of strontium-90 for application to the average of suitable samples of an exposed population.

The percent maximum concentration of radioactivity in the Clinch River at all points of measurements were less than 1 percent of the AEC radiation protection standards. The average concentration of transuranic alpha-particle emitters in the Clinch River at mile 20.8 was 0.01 pCi/liter which is 0.01 percent of the AEC radiation protection standard for water containing a mixture of unknown radionuclides.

The average concentration of natural uranium materials in the Clinch River reflecting the effects of all Oak Ridge plants was less than 0.1 percent of the AEC radiation standard for uranium.

The average external gamma radiation measured in the town of Oak Ridge and at the perimeter of the Oak Ridge area was 0.011 mR/h, which is approximately the same as that level measured during the period prior to Oak Ridge operations.

Previous coverage in *Radiological Health Data and Reports:*

| Period | Issue |
|---|---|
| January–June 1970 | November 1971 |


## Erratum

An error occurred in the Knolls Atomic Power Laboratory article on page 390 in the June 1973 issue. The third sentence in the second paragraph under "Effluent monitoring" should read:

"The total airborne particulate radioactivity discharged to the environment during the calendar year 1971 was less than 2 mCi."

Please make this change in your issues.

## Nuclear Power Reactors in the United States
## September 30, 1973

Each quarter year, the Atomic Energy Commission releases information on the status of all present and proposed civilian nuclear power generating units in the United States. This information is reproduced for interested readers of *Radiation Data and Reports.*

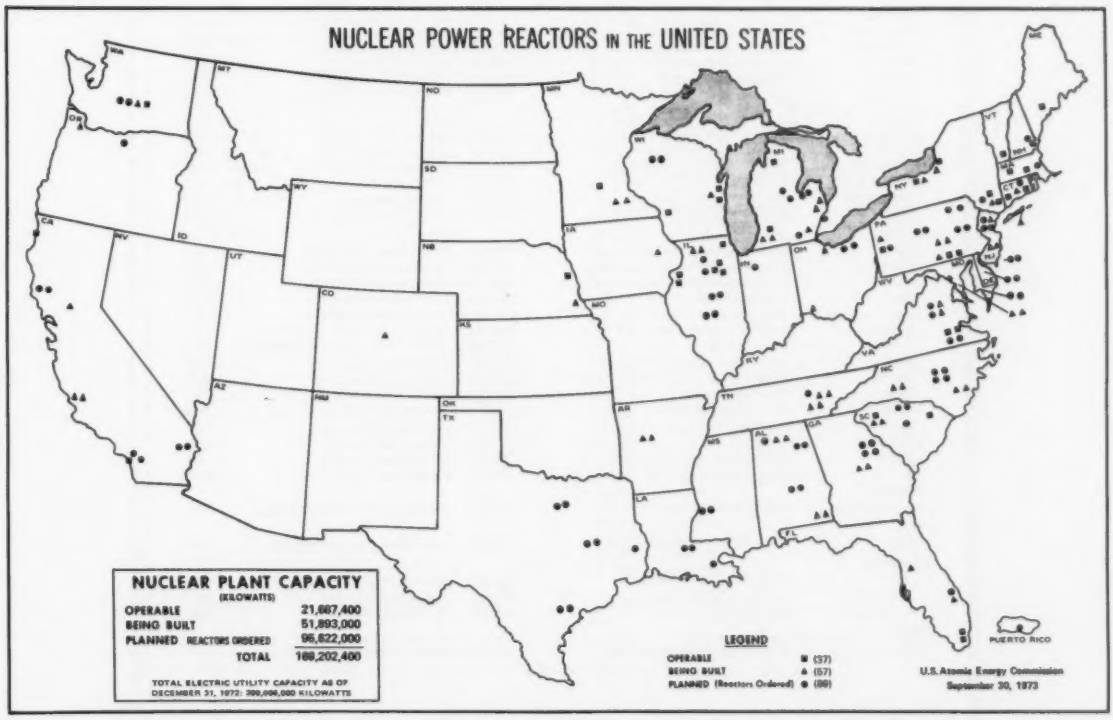


**Figure 1. Nuclear power reactors in the United States, September 30, 1973**

| SITE | PLANT NAME | CAPACITY (Net Kilowatts) | UTILITY | COMMERCIAL OPERATION |
|---|---|---|---|---|
| **ALABAMA** | | | | |
| Decatur | Browns Ferry Nuclear Power Plant: Unit 1 | 1,065,000 | Tennessee Valley Authority | 1973 |
| Decatur | Browns Ferry Nuclear Power Plant: Unit 2 | 1,065,000 | Tennessee Valley Authority | 1974 |
| Decatur | Browns Ferry Nuclear Power Plant: Unit 3 | 1,065,000 | Tennessee Valley Authority | 1974 |
| Dothan | Joseph M. Farley Nuclear Plant: Unit 1 | 829,000 | Alabama Power Co. | 1975 |
| Dothan | Joseph M. Farley Nuclear Plant: Unit 2 | 829,000 | Alabama Power Co. | 1977 |
| Orville | Central Alabama Nuclear Plant | 1,100,000 | Alabama Power Co. | 1980 |
| Orville | Central Alabama Nuclear Plant | 1,100,000 | Alabama Power Co. | 1981 |
| Scottsboro | Bellefonte Nuclear Plant: Unit 1 | 1,189,000 | Tennessee Valley Authority | 1979 |
| Scottsboro | Bellefonte Nuclear Plant: Unit 2 | 1,189,000 | Tennessee Valley Authority | 1980 |
| **ARKANSAS** | | | | |
| Russellville | Arkansas Nuclear One: Unit 1 | 850,000 | Arkansas Power & Light Co. | 1973 |
| Russellville | Arkansas Nuclear One: Unit 2 | 902,000 | Arkansas Power & Light Co. | 1976 |
| **CALIFORNIA** | | | | |
| Humboldt Bay | Humboldt Bay Power Plant: Unit 3 | 68,500 | Pacific Gas and Electric Co. | 1963 |
| San Clemente | San Onofre Nuclear Generating Station: Unit 1 | 430,000 | So. Calif. Ed. & San Diego Gas & El. Co. | 1968 |
| San Clemente | San Onofre Nuclear Generating Station: Unit 2 | 1,140,000 | So. Calif. Ed. & San Diego Gas & El. Co. | 1978 |
| San Clemente | San Onofre Nuclear Generating Station: Unit 3 | 1,140,000 | So. Calif. Ed. & San Diego Gas & El. Co. | 1979 |
| Diablo Canyon | Diablo Canyon Nuclear Power Plant: Unit 1 | 1,060,000 | Pacific Gas and Electric Co. | 1975 |
| Diablo Canyon | Diablo Canyon Nuclear Power Plant: Unit 2 | 1,060,000 | Pacific Gas and Electric Co. | 1976 |
| Clay Station | Rancho Seco Nuclear Generating Station | 913,000 | Sacramento Municipal Utility District | 1974 |
| * | – | 1,128,000 | Pacific Gas & Electric Co. | 1981 |
| * | – | 1,128,000 | Pacific Gas & Electric Co. | 1982 |
| * | Eastern Desert Plant: Unit 1 | 770,000 | Southern California Edison Co. | 1981 |
| * | Eastern Desert Plant: Unit 2 | 770,000 | Southern California Edison Co. | 1982 |
| **COLORADO** | | | | |
| Platteville | Ft. St. Vrain Nuclear Generating Station | 330,000 | Public Service Co. of Colorado | 1973 |
| **CONNECTICUT** | | | | |
| Haddam Neck | Haddam Neck Plant | 575,000 | Conn. Yankee Atomic Power Co. | 1968 |
| Waterford | Millstone Nuclear Power Station: Unit 1 | 652,100 | Northeast Utilities | 1971 |
| Waterford | Millstone Nuclear Power Station: Unit 2 | 828,000 | Northeast Utilities | 1974 |
| Waterford | Millstone Nuclear Power Station: Unit 3 | 1,150,000 | Northeast Utilities | 1979 |
| **DELAWARE** | | | | |
| Summit | Summit Power Station: Unit 1 | 770,000 | Delmarva Power & Light Co. | 1979 |
| Summit | Summit Power Station: Unit 2 | 770,000 | Delmarva Power & Light Co. | 1982 |
| **FLORIDA** | | | | |
| Florida City | Turkey Point Station: Unit 3 | 693,000 | Florida Power & Light Co. | 1972 |
| Florida City | Turkey Point Station: Unit 4 | 693,000 | Florida Power & Light Co. | 1973 |
| Red Level | Crystal River Plant: Unit 3 | 825,000 | Florida Power Corp. | 1973 |
| Ft. Pierce | St. Lucie Plant: Unit 1 | 801,000 | Florida Power & Light Co. | 1975 |
| Ft. Pierce | St. Lucie Plant: Unit 2 | 801,000 | Florida Power & Light Co. | 1978 |
| **GEORGIA** | | | | |
| Baxley | Edwin I. Hatch Nuclear Plant: Unit 1 | 786,000 | Georgia Power Co. | 1974 |
| Baxley | Edwin I. Hatch Nuclear Plant: Unit 2 | 795,000 | Georgia Power Co. | 1978 |
| Waynesboro | Alvin W. Vogtle, Jr. Plant: Unit 1 | 1,121,000 | Georgia Power Co. | 1980 |
| Waynesboro | Alvin W. Vogtle, Jr. Plant: Unit 2 | 1,121,000 | Georgia Power Co. | 1981 |
| Waynesboro | Alvin W. Vogtle, Jr. Plant: Unit 3 | 1,121,000 | Georgia Power Co. | 1982 |
| Waynesboro | Alvin W. Vogtle, Jr. Plant: Unit 4 | 1,121,000 | Georgia Power Co. | 1983 |
| **ILLINOIS** | | | | |
| Morris | Dresden Nuclear Power Station: Unit 1 | 200,000 | Commonwealth Edison Co. | 1960 |
| Morris | Dresden Nuclear Power Station: Unit 2 | 809,000 | Commonwealth Edison Co. | 1970 |
| Morris | Dresden Nuclear Power Station: Unit 3 | 809,000 | Commonwealth Edison Co. | 1971 |
| Zion | Zion Nuclear Plant: Unit 1 | 1,050,000 | Commonwealth Edison Co. | 1973 |
| Zion | Zion Nuclear Plant: Unit 2 | 1,050,000 | Commonwealth Edison Co. | 1974 |
| Cordova | Quad-Cities Station: Unit 1 | 800,000 | Comm. Ed. Co.-Ia.-Ill. Gas & Elec. Co. | 1972 |
| Cordova | Quad-Cities Station: Unit 2 | 800,000 | Comm. Ed. Co.-Ia.-Ill. Gas & Elec. Co. | 1972 |
| Seneca | LaSalle County Nuclear Station: Unit 1 | 1,078,000 | Comm. Ed. Co.-Ia. | 1977 |
| Seneca | LaSalle County Nuclear Station: Unit 2 | 1,078,000 | Comm. Ed. Co.-Ia. | 1978 |
| Bryon | Byron Station: Unit 1 | 1,120,000 | Comm. Edison Co. | 1979 |
| Bryon | Byron Station: Unit 2 | 1,120,000 | Comm. Edison Co. | 1980 |
| Braidwood | Braidwood: Unit 1 | 1,100,000 | Comm. Edison Co. | 1979 |
| Braidwood | Braidwood: Unit 2 | 1,100,000 | Comm. Edison Co. | 1980 |
| Clinton | Clinton Nuclear Power Plant: Unit 1 * | 950,000 | Illinois Power Co. | 1980 |
| Clinton | Clinton Nuclear Power Plant: Unit 2 | 950,000 | Illinois Power Co. | 1982 |
| **INDIANA** | | | | |
| Dune Acres | Bailly Generating Station | 660,000 | Northern Indiana Public Service Co. | 1977 |
| **IOWA** | | | | |
| Palo | Duane Arnold Energy Center: Unit 1 | 569,000 | Iowa Electric Light and Power Co. | 1974 |
| **LOUISIANA** | | | | |
| Taft | Waterford Generating Station | 1,113,000 | Louisiana Power & Light Co. | 1977 |
| St. Francisville | River Bend Station: Unit 1 | 934,000 | Gulf States Utilities Co. | 1980 |
| St. Francisville | River Bend Station: Unit 2 | 934,000 | Gulf States Utilities Co. | 1982 |
| **MAINE** | | | | |
| Wiscasset | Maine Yankee Atomic Power Plant | 790,000 | Maine Yankee Atomic Power Co. | 1972 |

**Figure 1. Nuclear power reactors in the United States, September 30, 1973—continued**

| SITE | PLANT NAME | CAPACITY (Net Kilowatts) | UTILITY | COMMERCIAL OPERATION |
|---|---|---|---|---|
| **MARYLAND** | | | | |
| Lusby | Calvert Cliffs Nuclear Power Plant: Unit 1 | 845,000 | Baltimore Gas and Electric Co. | 1974 |
| Lusby | Calvert Cliffs Nuclear Power Plant: Unit 2 | 845,000 | Baltimore Gas and Electric Co. | 1975 |
| Nanjemoy | Douglas Point Project: Unit 1 | 1,178,000 | Potomac Electric Power Co. | 1980 |
| Nanjemoy | Douglas Point Project: Unit 2 | 1,178,000 | Potomac Electric Power Co. | 1981 |
| **MASSACHUSETTS** | | | | |
| Rowe | Yankee Nuclear Power Station | 175,000 | Yankee Atomic Electric Co. | 1961 |
| Plymouth | Pilgrim Station: Unit 1 | 664,000 | Boston Edison Co. | 1972 |
| Plymouth | Pilgrim Station: Unit 2 | 1,180,000 | Boston Edison Co. | 1980 |
| **MICHIGAN** | | | | |
| Big Rock Point | Big Rock Point Nuclear Plant | 70,300 | Consumers Power Co. | 1965 |
| South Haven | Palisades Nuclear Power Station | 700,000 | Consumers Power Co. | 1971 |
| Lagoona Beach | Enrico Fermi Atomic Power Plant: Unit 2 | 1,123,000 | Detroit Edison Co. | 1976 |
| Lagoona Beach | Enrico Fermi Atomic Power Plant: Unit 3 | 1,125,000 | Detroit Edison Co. | 1979 |
| Bridgman | Donald C. Cook Plant: Unit 1 | 1,060,000 | Indiana & Michigan Electric Co. | 1974 |
| Bridgman | Donald C. Cook Plant: Unit 2 | 1,060,000 | Indiana & Michigan Electric Co. | 1975 |
| Midland | Midland Nuclear Power Plant: Unit 1 | 492,000 | Consumers Power Co. | 1980 |
| Midland | Midland Nuclear Power Plant: Unit 2 | 818,000 | Consumers Power Co. | 1979 |
| St. Clair County | Greenwood: Unit 2 | 1,240,000 | Detroit Edison Co. | 1980 |
| St. Clair County | Greenwood: Unit 3 | 1,240,000 | Detroit Edison Co. | 1981 |
| Quanicassee | Quanicassee: Unit 1 | 1,150,000 | Consumers Power Co. | 1981 |
| Quanicassee | Quanicassee: Unit 2 | 1,150,000 | Consumers Power Co. | 1982 |
| **MINNESOTA** | | | | |
| Monticello | Monticello Nuclear Generating Plant | 545,000 | Northern States Power Co. | 1971 |
| Red Wing | Prairie Island Nuclear Generating Plant: Unit 1 | 530,000 | Northern States Power Co. | 1973 |
| Red Wing | Prairie Island Nuclear Generating Plant: Unit 2 | 530,000 | Northern States Power Co. | 1974 |
| **MISSISSIPPI** | | | | |
| Port Gibson | Grand Gulf Nuclear Station: Unit 1 | 1,290,000 | Mississippi Power & Light Co. | 1979 |
| Port Gibson | Grand Gulf Nuclear Station: Unit 2 | 1,290,000 | Mississippi Power & Light Co. | 1981 |
| **NEBRASKA** | | | | |
| Fort Calhoun | Ft. Calhoun Station: Unit 1 | 457,400 | Omaha Public Power District | 1973 |
| Brownville | Cooper Nuclear Station | 778,000 | Nebraska Public Power District and Iowa Power and Light Co. | 1974 |
| **NEW HAMPSHIRE** | | | | |
| Seabrook | Seabrook Nuclear Station: Unit 1 | 1,200,000 | Public Service of N.H. | 1979 |
| Seabrook | Seabrook Nuclear Station: Unit 2 | 1,200,000 | Public Service of N.H. | 1981 |
| **NEW JERSEY** | | | | |
| Toms River | Oyster Creek Nuclear Power Plant: Unit 1 | 640,000 | Jersey Central Power & Light Co. | 1969 |
| Forked River | Forked River Generating Station: Unit 1 | 1,070,000 | Jersey Central Power & Light Co. | 1978 |
| Salem | Salem Nuclear Generating Station: Unit 1 | 1,090,000 | Public Service Electric and Gas, N.J. | 1975 |
| Salem | Salem Nuclear Generating Station: Unit 2 | 1,115,000 | Public Service Electric and Gas, N.J. | 1976 |
| Bordentown | Newbold Nuclear Generating Station: Unit 1 | 1,067,000 | Public Service Electric and Gas, N.J. | 1981 |
| Bordentown | Newbold Nuclear Generating Station: Unit 2 | 1,067,000 | Public Service Electric and Gas, N.J. | 1982 |
| Little Egg Inlet | Atlantic Generating Station: Unit 1 | 1,150,000 | Public Service Electric and Gas, N.J. | 1980 |
| Little Egg Inlet | Atlantic Generating Station: Unit 2 | 1,150,000 | Public Service Electric and Gas, N.J. | 1981 |
| **NEW YORK** | | | | |
| Indian Point | Indian Point Station: Unit 1 | 265,000 | Consolidated Edison Co. | 1962 |
| Indian Point | Indian Point Station: Unit 2 | 873,000 | Consolidated Edison Co. | 1973 |
| Indian Point | Indian Point Station: Unit 3 | 965,000 | Consolidated Edison Co. | 1974 |
| Scriba | Nine Mile Point Nuclear Station: Unit 1 | 625,000 | Niagara Mohawk Power Co. | 1969 |
| Scriba | Nine Mile Point Nuclear Station: Unit 2 | 1,080,000 | Niagara Mohawk Power Co. | 1978 |
| Ontario | R.E.Ginna Nuclear Power Plant: Unit 1 | 470,000 | Rochester Gas & Electric Co. | 1970 |
| Brookhaven | Shoreham Nuclear Power Station | 819,000 | Long Island Lighting Co. | 1977 |
| Scriba | James A. Fitzpatrick Nuclear Power Plant | 821,000 | Power Authority of State of N.Y. | 1973 |
| • | | 1,150,000 | Long Island Lighting Co. | 1981 |
| **NORTH CAROLINA** | | | | |
| Southport | Brunswick Steam Electric Plant: Unit 1 | 821,000 | Carolina Power and Light Co. | 1975 |
| Southport | Brunswick Steam Electric Plant: Unit 2 | 821,000 | Carolina Power and Light Co. | 1974 |
| Cowans Ford Dam | Wm. B. McGuire Nuclear Station: Unit 1 | 1,180,000 | Duke Power Co. | 1976 |
| Cowans Ford Dam | Wm. B. McGuire Nuclear Station: Unit 2 | 1,180,000 | Duke Power Co. | 1977 |
| Bonsal | Shearon Harris Plant: Unit 1 | 915,000 | Carolina Power & Light Co. | 1978 |
| Bonsal | Shearon Harris Plant: Unit 2 | 915,000 | Carolina Power & Light Co. | 1979 |
| Bonsal | Shearon Harris Plant: Unit 3 | 915,000 | Carolina Power & Light Co. | 1980 |
| Bonsal | Shearon Harris Plant: Unit 4 | 915,000 | Carolina Power & Light Co. | 1981 |
| • | – | 1,200,000 | Duke Power Co. | 1981 |
| • | – | 1,200,000 | Duke Power Co. | 1982 |
| • | – | 1,200,000 | Duke Power Co. | 1983 |
| • | – | 1,200,000 | Duke Power Co. | 1984 |
| • | – | 1,200,000 | Duke Power Co. | 1985 |
| • | – | 1,200,000 | Duke Power Co. | 1986 |
| **OHIO** | | | | |
| Oak Harbor | Davis-Besse Nuclear Power Station | 906,000 | Toledo Edison-Cleveland Electric Illuminating Co. | 1975 |
| Perry | Perry Nuclear Power Plant: Unit 1 | 1,205,000 | Cleveland Electric Illuminating Co. | 1979 |
| Perry | Perry Nuclear Power Plant: Unit 2 | 1,205,000 | Cleveland Electric Illuminating Co. | 1980 |
| Moscow | Wm. H. Zimmer Nuclear Power Station: Unit 1 | 810,000 | Cincinnati Gas & Electric Co. | 1977 |

**Figure 1. Nuclear power reactors in the United States, September 30, 1973—continued**

| SITE | PLANT NAME | CAPACITY (Net Kilowatts) | UTILITY | COMMERCIAL OPERATION |
|---|---|---|---|---|
| **OREGON** | | | | |
| Prescott | Trojan Nuclear Plant: Unit 1 | 1,130,000 | Portland General Electric Co. | 1975 |
| Boardman | | 1,200,000 | Portland General Electric Co. | 1980 |
| **PENNSYLVANIA** | | | | |
| Peach Bottom | Peach Bottom Atomic Power Station: Unit 1 | 40,000 | Philadelphia Electric Co. | 1967 |
| Peach Bottom | Peach Bottom Atomic Power Station: Unit 2 | 1,065,000 | Philadelphia Electric Co. | 1973 |
| Peach Bottom | Peach Bottom Atomic Power Station: Unit 3 | 1,065,000 | Philadelphia Electric Co. | 1974 |
| Pottstown | Limerick Generating Station: Unit 1 | 1,065,000 | Philadelphia Electric Co. | 1979 |
| Pottstown | Limerick Generating Station: Unit 2 | 1,065,000 | Philadelphia Electric Co. | 1980 |
| Shippingport | Shippingport Atomic Power Station: Unit 1 | 90,000 | Duquesne Light Co. | 1957 |
| Shippingport | Beaver Valley Power Station: Unit 1 | 852,000 | Duquesne Light Co.-Ohio Edison Co. | 1974 |
| Shippingport | Beaver Valley Power Station: Unit 2 | 852,000 | Duquesne Light Co.-Ohio Edison Co. | 1978 |
| Goldsboro | Three Mile Island Nuclear Station: Unit 1 | 819,000 | Metropolitan Edison Co. | 1974 |
| Goldsboro | Three Mile Island Nuclear Station: Unit 2 | 905,000 | Jersey Central Power & Light Co. | 1976 |
| Berwick | Susquehanna Steam Electric Station: Unit 1 | 1,052,000 | Pennsylvania Power and Light | 1979 |
| Berwick | Susquehanna Steam Electric Station: Unit 2 | 1,052,000 | Pennsylvania Power and Light | 1981 |
| Fuller | Fulton Generating Station: Unit 1 | 1,140,000 | Philadelphia Electric Co. | 1981 |
| Fuller | Fulton Generating Station: Unit 2 | 1,140,000 | Philadelphia Electric Co. | 1983 |
| **SOUTH CAROLINA** | | | | |
| Hartsville | H. B. Robinson S.E. Plant: Unit 2 | 700,000 | Carolina Power & Light Co. | 1971 |
| Seneca | Oconee Nuclear Station: Unit 1 | 886,000 | Duke Power Co. | 1973 |
| Seneca | Oconee Nuclear Station: Unit 2 | 886,000 | Duke Power Co. | 1973 |
| Seneca | Oconee Nuclear Station: Unit 3 | 886,000 | Duke Power Co. | 1974 |
| Broad River | Virgil C. Summer Nuclear Station: Unit 1 | 900,000 | South Carolina Electric & Gas Co. | 1978 |
| Lake Wylie | Catawba Nuclear Station: Unit 1 | 1,180,000 | Duke Power Co. | 1979 |
| Lake Wylie | Catawba Nuclear Station: Unit 2 | 1,180,000 | Duke Power Co. | 1980 |
| **TENNESSEE** | | | | |
| Daisy | Sequoyah Nuclear Power Plant: Unit 1 | 1,140,000 | Tennessee Valley Authority | 1975 |
| Daisy | Sequoyah Nuclear Power Plant: Unit 2 | 1,140,000 | Tennessee Valley Authority | 1976 |
| Spring City | Watts Bar Nuclear Plant: Unit 1 | 1,169,000 | Tennessee Valley Authority | 1978 |
| Spring City | Watts Bar Nuclear Plant: Unit 2 | 1,169,000 | Tennessee Valley Authority | 1978 |
| Oak Ridge | Clinch River Breeder Reactor Plant | 400,000 | Project Management Corporation | 1980 |
| **TEXAS** | | | | |
| Glen Rose | Commanche Peak Steam Electric Station: Unit 1 | 1,150,000 | Texas Utilities Services Inc. | 1980 |
| Glen Rose | Commanche Peak Steam Electric Station: Unit 2 | 1,150,000 | Texas Utilities Services Inc. | 1982 |
| Jasper | Blue Hills: Unit 1 | 918,000 | Gulf States Utilities | 1980 |
| Wallis | Allens Creek: Unit 1 | 1,150,000 | Houston Lighting & Power Co. | 1980 |
| Wallis | Allens Creek: Unit 2 | 1,150,000 | Houston Lighting & Power Co. | 1982 |
| Bay City | South Texas Project | 1,250,000 | Central Power & Light Co. | 1980 |
| Bay City | South Texas Project | 1,250,000 | Central Power & Light Co. | 1982 |
| **VERMONT** | | | | |
| Vernon | Vermont Yankee Generating Station | 513,900 | Vermont Yankee Nuclear Power Corp. | 1972 |
| **VIRGINIA** | | | | |
| Gravel Neck | Surry Power Station: Unit 1 | 788,000 | Virginia Electric & Power Co. | 1972 |
| Gravel Neck | Surry Power Station: Unit 2 | 788,000 | Virginia Electric & Power Co. | 1973 |
| Mineral | North Anna Power Station: Unit 1 | 898,000 | Virginia Electric & Power Co. | 1974 |
| Mineral | North Anna Power Station: Unit 2 | 898,000 | Virginia Electric & Power Co. | 1975 |
| Mineral | North Anna Power Station: Unit 3 | 907,000 | Virginia Electric & Power Co. | 1977 |
| Mineral | North Anna Power Station: Unit 4 | 907,000 | Virginia Electric & Power Co. | 1978 |
| Gravel Neck | Surry Power Station: Unit 3 | 882,000 | Virginia Electric & Power Company | 1980 |
| Gravel Neck | Surry Power Station: Unit 4 | 882,000 | Virginia Electric & Power Company | 1981 |
| **WASHINGTON** | | | | |
| Richland | N-Reactor/WPPSS Steam | 800,000 | Atomic Energy Commission | 1966 |
| Richland | WPPSS No. 1 | 1,120,000 | Washington Public Power Supply System | 1980 |
| Richland | WPPSS No. 2 | 1,103,000 | Washington Public Power Supply System | 1977 |
| Satsop | WPPSS No. 3 | 1,200,000 | Washington Public Power Supply System | 1981 |
| **WISCONSIN** | | | | |
| Genoa | Genoa Nuclear Generating Station | 53,200 | Dairyland Power Cooperative | 1971 |
| Two Creeks | Point Beach Nuclear Plant: Unit 1 | 497,000 | Wisconsin Michigan Power Co. | 1970 |
| Two Creeks | Point Beach Nuclear Plant: Unit 2 | 497,000 | Wisconsin Michigan Power Co. | 1972 |
| Carlton | Kewaunee Nuclear Power Plant: Unit 1 | 541,000 | Wisconsin Michigan Power Co. | 1973 |
| * | | 900,000 | Wisconsin Electric Power Co. | 1980 |
| * | | 900,000 | Wisconsin Electric Power Co. | 1982 |
| **PUERTO RICO** | | | | |
| Puerto De Jobas | Aguirre Nuclear Power Plant | 583,000 | Puerto Rico Water Resources Authority | 1979 |
| * | – | 1,128,000 | Tennessee Valley Authority | 1980 |
| * | – | 1,128,000 | Tennessee Valley Authority | 1981 |
| * | – | 1,128,000 | Tennessee Valley Authority | 1980 |
| * | – | 1,128,000 | Tennessee Valley Authority | 1981 |

* Site not selected.

**Figure 1. Nuclear power reactors in the United States, September 30, 1973—continued**

## Reported Nuclear Detonations, November 1973

**(Includes seismic signals presumably from foreign nuclear detonations)**

There were no reported nuclear detonations for the United States for November 1973, and no seismic signals were recorded during this month.

Not all of the nuclear detonations in the United States are announced immediately, therefore, the information in this section may not be complete. A complete list of announced U.S. nuclear detonations may be obtained upon request from the Division of Public Information, U.S. Atomic Energy Commission, Washington, D.C. 20545.

# Author Index

## Radiation Data and Reports — Volume 14—1973

# Annual Subject Index

## Radiation Data and Reports — Volume 14—1973

## A



## B

## R



## S



## T



## U, V



## W

## X, Y, Z

## SYNOPSES

Synopses of reprots, incorporating a list of key words, are furnished below in reference card format for the convenience of readers who may wish to clip them for their fines.

VERTICAL DISTRIBUTION OF FALLOUT CESIUM-137 IN CULTIVATED SOILS. *J. C. Ritchie* and *J. R. McHenry. Radiation Data and Reports, Vol. 14, December 1973,* pp. 727–728.

Fallout cesium-137 was found to be evenly distributed in the upper 15-20 cm of cultivated soils of five watersheds in the mid-United States. This distribution pattern is markedly different from the vertical distribution of cesium-137 in noncultivated soils.

KEYWORDS: Cesium-137, fallout, mid-United States, soil, watershed.

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